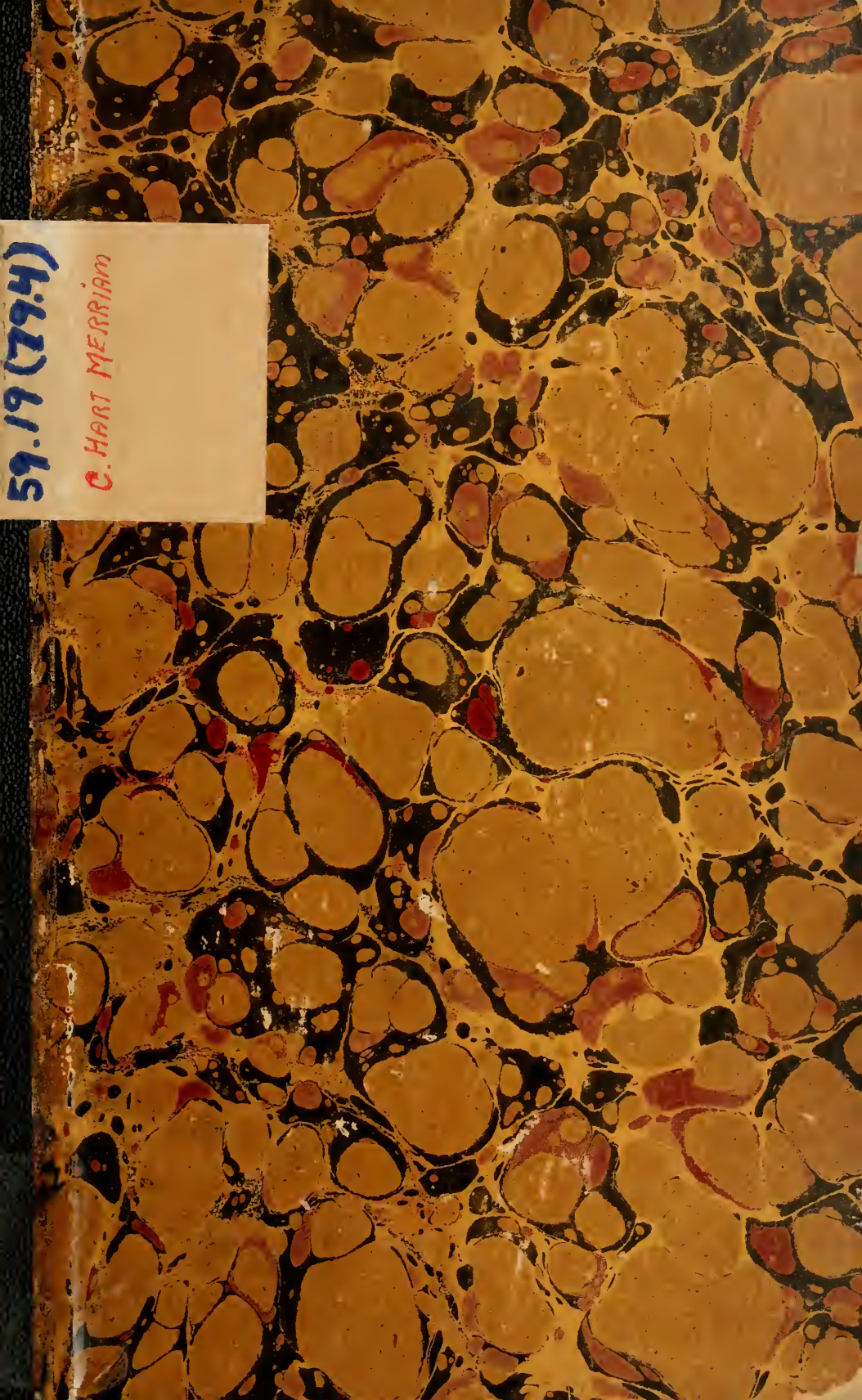


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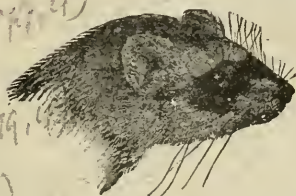


U. S. DEPARTMENT OF AGRICULTURE
DIVISION OF BIOLOGICAL SURVEY

NORTH AMERICAN FAUNA

No. 16

[Actual date of publication, October -28, 1899]



RESULTS OF A BIOLOGICAL SURVEY OF MOUNT SHASTA CALIFORNIA

BY

C. HART MERRIAM
CHIEF OF DIVISION OF BIOLOGICAL SURVEY



WASHINGTON
GOVERNMENT PRINTING OFFICE
1899

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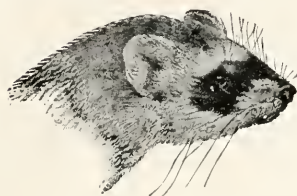


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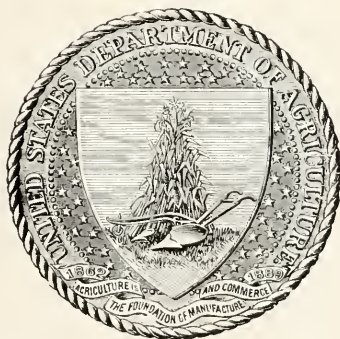
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RESULTS OF A BIOLOGICAL SURVEY OF MOUNT SHASTA CALIFORNIA

BY

C. HART MERRIAM
CHIEF OF DIVISION OF BIOLOGICAL SURVEY



WASHINGTON
GOVERNMENT PRINTING OFFICE
1899

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF BIOLOGICAL SURVEY,
Washington, D. C., May 19, 1899.

SIR: I have the honor to transmit herewith for publication, as North American Fauna No. 16, a report on the results of a Biological Survey of Mount Shasta, California, made during the summer of 1898.

Respectfully,

C. HART MERRIAM,
Chief, Biological Survey.

Hon. JAMES WILSON,
Secretary of Agriculture.

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RESULTS OF A BIOLOGICAL SURVEY OF MOUNT SHASTA, NORTHERN CALIFORNIA.

By C. HART MERRIAM.

INTRODUCTION.

At the close of the field season of 1897 the Biological Survey had nearly completed a reconnoissance of Washington and Oregon, and in previous years had carried its operations over extensive tracts in southern, middle, and northeastern California, so that with the exception of a rather large area in northern California fully two-thirds of the Pacific States had been covered. In 1898, therefore, the unworked part of northern California, reaching from the Madeline Plains on the east to the Pacific Ocean on the west, and from the Oregon boundary on the north to Lassen Butte and adjacent parts of the Sierra on the south, came to be the principal field of our investigations. In this area Mount Shasta occupies a nearly central position.

All high mountains, particularly those that stand alone, are likely to throw light on the problems of geographic distribution and are worthy of careful study. Shasta, not only because of its great altitude, but even more because of its intermediate position between the Sierra and the Cascades, promised an instructive lesson, and was therefore chosen as a base station for part of the field work of 1898.

From work previously done in the Sierra Nevada of California and the Cascade Range of Oregon it was known that many species of animals and plants are common to both ranges, and many restricted to one or the other. Shasta, lying between the two, was expected to share the common features of both, and in addition afford the northernmost limit of Sierra species, the southernmost limit of Cascade species, or an overlapping of both, so that its fauna and flora, other things being equal, should be richer than either. But Shasta proved very much drier than either the Sierra or the Cascades, and consequently many species common to the two ranges were absent, and the total number was less than was expected. Nevertheless, the mountain shares a large

percentage of the common species and is, as expected, a stepping stone on which restricted Sierra and Cascade species overlap. But the representatives of the two ranges are not equally apportioned. The most evident gap is on the north, Shasta sharing many more species in common with the Sierra than with the Cascades. Indeed, the resemblance to the northern Sierra is so exceedingly close, particularly in the mammal fauna, that from the standpoint of geographic distribution Shasta could without violence be classed as part of the Sierra. This is the more surprising in view of the fact that the geographical gap between Shasta and the Cascades is only half as broad as that between Shasta and the Sierra. This subject is discussed in detail in the chapters entitled 'The Boreal fauna and flora of Shasta contrasted with corresponding faunas and floras of the Sierra and the Cascades;' 'Efficiency of Klamath Gap as a barrier to Boreal species compared with that of Pitt River and Feather River gaps collectively;' and 'Sources of the Boreal faunas of Shasta and of the Sierra and the Cascades.'

ITINERARY.

Leaving the railroad at Sisson, at the west base of Shasta, we established the first camp July 15, 1898, at a point known as Wagon Camp,



FIG. 1.—Wagon Camp.

on the south slope of the mountain, about a quarter of a mile west of Panther Creek, at an altitude of 5,700 feet (fig. 1). Wagon Camp is situ-

ated in a descending tongue of Shasta firs between ascending tongues of manzanita chaparral, just above the uppermost grove of ponderosa pines, on the boundary between the Canadian and Transition zones. It is abundantly supplied with water from several small springs, from which tiny streamlets run short distances before disappearing in the thirsty soil. Some of these springs unite to form a small marsh, in which flourish a number of plants not found elsewhere on the mountain. It is naturally a favorite spot for birds, and more species were seen here than elsewhere. Wagon Camp was occupied continuously by one or more members of the party from July 15 to August 1, and at brief intervals thereafter until October 3.

A few days after reaching the mountain I set out on a trip around the peak in order to become familiar with the general features of the region and lay plans for the season's work. On this trip I was accompanied by Vernon Bailey, my most experienced field assistant, and by a



FIG. 2.—Shasta from east brink of Mud Creek Canyon.

voluntary assistant, Lyman L. Merriam. We took saddle horses and a pack animal, which were of material aid, although we had much difficulty in getting them across some of the deep canyons and over the indescribably rough lava on the west side of the mountain.

Leaving Wagon Camp on the morning of July 22, we ascended Panther Creek to its source, turned easterly through 'The [South] Gate,' north of Gray and Red buttes, crossed Squaw Creek near its head, and kept on among the timberline white-bark pines to the rim of Mud Creek Canyon (pl. III), which we followed down into the Shasta firs. The first night was spent in the bottom of this canyon at an altitude of 5,600 feet—some distance below the lower fall. The second day we climbed the steep east bank of the canyon, here 1,000 feet deep (fig. 2), crossed Cold Creek and Ash Creek Canyon below timberline, and reached

Brewer Creek Canyon in the upper part of the white-bark pines. Finding absolutely no grass or other feed for the animals here, we crossed the canyon lower down (a little below the forks) and continued on over rough lava ridges in the upper edge of the forest until dark, when we camped on Inconstance Creek (fig. 3). The third day we pushed



FIG. 3.—Shasta from Inconstance Creek, near timberline on north side.

on around the north end of the mountain, keeping a little below the great glaciers, and in the main near timberline. We climbed over a number of lava ridges, availed ourselves of a natural passageway ('North Gate') at the upper end of a pair of conspicuous lava buttes, traversed a curious pumice plain covered with timberline mats of prostrate white-bark pines (fig. 22), crossed the fearful canyons of Whitney and Bolam creeks, and finally reached Shastina, where, after a very severe day, we camped on some small streams of snow water on the north side (fig. 4). The fourth morning we climbed the rough slide rock of Shastina to an altitude of 10,000 feet, in order to get around a high impassable lava ridge, and then, after encircling a great amphitheater of rough slide rock, descended by some immense masses of perpetual snow to the white-bark pines, in which we continued to the great canyon on the west side of Shastina (pl. II), which I named Diller Canyon, in honor of J. S. Diller of the U. S. Geological Survey, in recognition of his admirable researches on the geology of Shasta. After crossing Diller Canyon we kept in the upper part of the Shasta fir forest all the way to Panther Creek, which we followed down to Wagon Camp. This

was the most trying day of all—sixteen miles of continual climbing, removing blocks of lava, and building trail. Our animals suffered



FIG. 4.—Shastina from north, showing great bank of snow which feeds Shastina streams.

severely, and one of them gave out entirely. However, the mountain was completely encircled after four long days, and the desired informa-

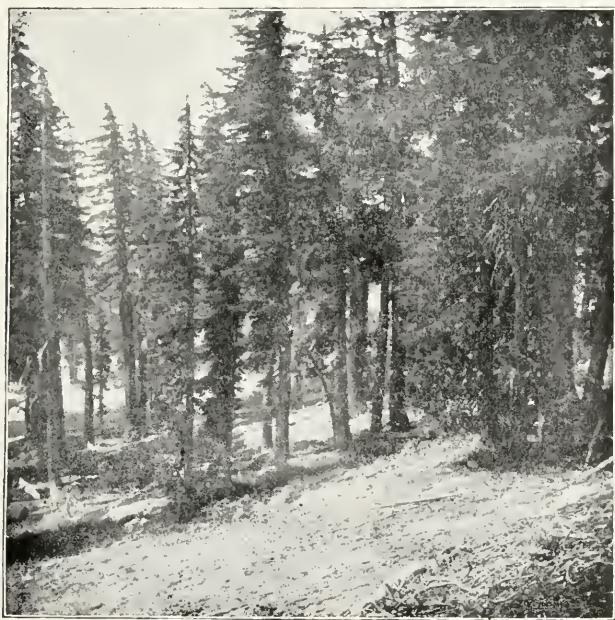


FIG. 5.—Alpine hemlocks, Squaw Creek Camp.

tion was obtained. In the main we kept near timberline, climbing over the bare rock slopes above, or descending into the dark forest below,

as occasion required. And since all the canyons of Shasta radiate from the summit, all were crossed on this trip.

A base camp was next established in a grove of black alpine hemlocks near the head of the west branch of Squaw Creek, close to and just east of the upper end of Red Butte. Here one or more of the party remained continuously from August 1 till September 24. All things considered, this is probably the best camping ground on Shasta, though I am not aware that it had been used before our visit. It is close by the three upper 'meadows' on Squaw Creek and within reach of the best feed for horses found on the mountain, with the possible exception



FIG. 6.—Heather meadow on Squaw Creek.

of a small area near Cold Creek, and it is by far the most convenient base from which to work the timberline region of the southern slopes.

Temporary camps were established at the head of Panther Creek, in Mud Creek Canyon at the mouth of Clear Creek, in Ash Creek Canyon a little below timberline, and high up between Mud Creek Canyon and the head of Clear Creek, from which point the main peak was twice ascended. At the base of the mountain, work was done at Sisson on the west side, in Squaw Creek and McCloud valleys on the south, and in Shasta and Little Shasta valleys on the north, and finally a trip was made completely around the mountain, mainly within the belt of yellow pines which clothes its lower slopes.

PERSONNEL.

In the field work on which the present report is based, I was aided by Vernon Bailey, chief field naturalist of the Biological Survey, and my assistants, Wilfred H. Osgood, Walter K. Fisher, and Richard T. Fisher. Vernon Bailey had charge of the work at the Shasta base camps and on a trip around the base of the mountain; Walter K. Fisher had charge of the work in Mud Creek and Ash Creek canyons and near timberline east of Mud Creek, and afterwards took a party to Fall River Lake and Lassen Butte; W. H. Osgood had charge of the work on Lassen after Walter Fisher's departure, and also visited Squaw Creek and Shasta and Little Shasta valleys; R. T. Fisher spent the season working from the various camps on Shasta and at Sisson, and accompanied Osgood on the trip to Little Shasta Valley.¹

Our camps on Shasta were visited by Henry Gannett, chief geographer of the U. S. Geological Survey; John H. Sage, of Connecticut, secretary of the American Ornithologists' Union; and two or three others, all of whom rendered important assistance.

In addition to the work on and near Shasta covered by the present report, field work was done in various directions. Three cross sections of the Sierra Nevada, north of latitude 39°, were made by Bailey, Osgood, and myself; Bailey and Walter Fisher ran a line from Black Rock Desert, Nevada, to Shasta, by way of Madeline Plains; Bailey and I, accompanied by Henry Gannett, carried the work across the wild and little known mountains from Shasta to the ocean, which we reached at Humboldt Bay; and later in the season much work was done farther south, chiefly in the inner and outer Coast Ranges.

PREVIOUS PUBLICATIONS.

Only two publications have been found relating to the zoology and botany of the Shasta region. The first is a report by Charles H. Townsend, of the U. S. Fish Commission, who, fifteen years before our visit, was stationed at Baird, a fish hatchery on McCloud River. While there Mr. Townsend visited Berryvale (now Sisson Tavern) and accompanied Major Gilbert Thompson, who was in charge of a triangulation party of the U. S. Geological Survey, in his field work on Shasta. The results of Mr. Townsend's work are contained in an important report entitled 'Field Notes on the Mammals, Birds, and Reptiles of Northern California,' published in the fall of 1887.² In addition to the records in this report, Mr. Townsend has kindly placed his manuscript catalogue at my disposal, and has in several instances given me important sup-

¹ While this report was passing through the press (July, 1899), I sent Walter K. Fisher to Mount Shasta and Shasta Valley to obtain supplemental information, some of which is incorporated in the mammal, bird, and plant reports at the end.—C. H. M.

² Proc. U. S. National Museum, X, pp. 159-241, Nov., 1887.

plementary information respecting the exact localities at which specimens were collected, all of which is duly credited in the body of the present report.

The second publication referred to is a brief paper by Miss Alice Eastwood on 'The Alpine Flora of Mount Shasta,'¹ containing the results of a hasty trip to the summit made in August, 1893.

So far as I have been able to ascertain, this is the first and only publication relating directly to Shasta plants, although a number of species collected there during a brief visit by Prof. Wm. H. Brewer in the early sixties are mentioned in the Botany of California (by Brewer and Watson, 1876-1880).

NEW SPECIES.

In working up the collections it was found that several of the plants and mammals belonged to undescribed species. Some of the new plants have been described by Prof. E. L. Greene;² others remain unnamed. The new mammals are here described. The new species are:

Plants.

Agoseris monticola.
Arnica merriami.
Campanula wilkinsiana.
Phacelia frigida.
Pyrola pallida.

Mammals.

Lepus klamathensis.
Lynx fasciatus pallescens.
Neotrichus gibbsi major.
Procyon psora pacifica.
Reithrodontomys klamathensis.
Sorex shastensis.
Thomomys monticola pinetorum.
Urocyon californicus townsendi.

¹ *Erythea*, IV, No. 9, pp. 136-142, Sept., 1896.

² *Pittonia*, IV, pp. 36-40, March 17, 1899.

GENERAL FEATURES OF SHASTA.

The snowy peak of Shasta, the pride of California, is one of the highest and most accessible of the snow-clad glacier-bearing mountains of the United States. It is an old volcano, 14,450 feet in altitude, and is completely cut off from neighboring mountains—from Lassen Peak, at the north end of the Sierra proper, by the valleys of the McCloud and Pitt rivers; from the south end of the Cascade Range in Oregon by a broad lava plateau and the valley of Klamath River. The breadth of the gap on the north is diminished by a cluster of low volcanic mountains known as the Goose Nest Group.

Shasta is the best-known landmark in California. Seen from the north, south, and east it appears as a single cone pushing its lofty crown upward six or seven thousand feet above apparent timberline. Seen from the west and southwest its summit is elongated and looks more like the crest of a ridge (frontispiece). This appearance is due in part to a large secondary volcano, Shastina, which rises from the northwest shoulder of the mountain, and in part to a long ridge which pushes out to the south. This west side, the one seen by tourists in traveling over the Shasta route from San Francisco to Portland, is in many respects the least interesting. From its exposure to the direct rays of the afternoon sun it is the hottest slope, and consequently the one on which timber reaches highest and on which the ice and snow are most reduced.

Like most isolated mountains, Shasta is seen to best advantage from a distance. The most imposing view to my mind is from the northeast, the region of the Modoc lava beds, from which the peak looms up in all its icy grandeur—a single massive cone buried from top almost to bottom in continuous glaciers, below which it is encircled by a dark belt of coniferous forest. It is also very imposing as seen from the distant Trinity Mountains.

The north and east sides of the peak are completely, and the south side partly covered by glaciers, but not a glacier is to be found on the west, where the large masses of white seen from Sisson are banks of snow, more or less permanent. The only glacier visible from the railroad is Whitney Glacier, which occupies the notch between Shasta and Shastina, and may be seen from points north of Edgewood. The higher slopes, between the lower edge of the ice and snow and the upper edge of the forest, are steep and rocky. In the main they consist of radiating ridges alternating with glacial basins and precipitous canyons. As a rule the surface is light pumice and pumice sand thickly strewn with fragments of gray volcanic rock, interrupted here and there by masses and cliffs of darker lava, often reddish brown in color.

The south and east sides, except the deep canyons of Mud, Ash, and Brewer creeks, are fair traveling for mountain horses. The north side, below the great glaciers, is interrupted by exceedingly rough lava ridges and the terrible canyons of Bolam and Whitney creeks. The west side, though scored by only a single notable canyon—Diller Canyon (pl. II)—is by far the most difficult. After crossing the tremendous slopes of steep and sharp slide rock, very dangerous for horses, on the northwest side of Shastina, and surmounting the two principal lava ridges west of Shastina Creek, the way to Diller Canyon is comparatively easy. But between Diller Canyon and Cascade Gulch, a mile or so north of Horse Camp, and extending from timberline downward several thousand feet, is a chaos of lava the like of which I have never seen. It suggests the worst parts of the Snake River and Modoc lava beds turned up on end—basins, ridges, and tumultuous piles without order or direction, without beginning or ending—dry basins that empty nowhere, drier ridges that lead nowhere, until one is worn out with thirst and efforts to escape. The whole is hidden in a dark forest of Shasta firs whose hardy trunks force themselves out between the lava blocks in ways that almost surpass belief. Finally all this stops as suddenly as it began, and one emerges from the dark inferno to slake his thirst in the refreshing pools of Cascade Gulch—known only to the deer—and, with a sense of infinite relief, reenters the area of pumice

sand and gray shale which stretches away to the southeast and thence onward around three-quarters of the mountain.

The timbered valley at the west base of Shasta falls away both to the south and to the north. On the south it drains immediately into the Sacramento River; on the north into the Shasta River, which traverses Shasta Valley and empties into Klamath River. Shasta Valley is an open plain northwest



FIG. 7.—Pumice sand strewn with gray volcanic shale. Young hemlocks in foreground; white-bark pines in distance.

of the mountain; it is lowest at the north, and its northwestern corner ends in a pocket or basin containing the mining town of Yreka, which is doubtless the hottest part of northern California west of the axis of the Sierra-Cascade system.



MOUNT SHASTA FROM THE NORTHWEST, SHOWING GREAT SNOWBANK IN HEAD OF DILLER CANYON.

THE HELIOTYPE PRINTING CO., BOSTON

EFFECTS OF SCANTY MOISTURE.

The flora of Shasta, contrasted with that of moister mountains immediately north and immediately south, is poor in species and individuals; and the same is true in less degree of the fauna. At least nineteen characteristic genera and numerous additional species of plants common to the Sierra and the Cascades, are unknown (p. 80); and to these must be added the distinctive species of each range which fail to reach Shasta. The luxuriant mountain meadows and flower beds that form such conspicuous features of the timberline region in the Cascades, the Olympics, the High Sierra, and the Rocky Mountains are wholly absent, and the only areas that in any way resemble them are the



FIG. 8.—Heather meadow bordering Squaw Creek. Shasta peak in distance covered with fresh snow, September 22, 1898.

insignificant patches of mountain heather and accompanying plants that carpet the moist bottoms of the glacier basins and form narrow beds along the tiny streams, where they are concentrated by the local distribution of soil moisture. The only real soil above timberline is restricted to the borders of the streamlets, where the decomposing heather has left a shallow covering. Everywhere else are pumice, broken lava, and barren cliffs.

The summer rainfall amounts to little or nothing, and when rains occur they sink and vanish in the thirsty pumice sand. The streams from melting snows are exceedingly small, averaging hardly more than a foot or two in width, and most of them disappear before reaching the base of the mountain. The turbid streams from the glaciers are larger,

but they have cut for themselves deep gorges where they run their rapid courses 1,000 feet below the surface, and consequently are useless for purposes of general irrigation. They exert a local influence, it is true, since far down in the damp bottoms of the canyons and along their cool easterly lower slopes a number of moisture-loving plants occur that are not found elsewhere except about the few and widely scattered springs in the forest—serving by contrast to accentuate the general aridity. Even the black alpine hemlock, which in the Cascades forms so attractive a feature of the upper slopes, is of local occurrence on Shasta, where its distribution is interesting as furnishing an index to soil moisture. It is associated with the white-bark pine (*Pinus albicaulis*), which requires less moisture and is the dominant timberline tree. In our circuit of the peak we found the range of the white-bark pine practically continuous; that of the alpine hemlock discontinuous and greatly restricted. As a rule the hemlock is confined to narrow strips along the streams and gulches, or to tongues along the cool east sides of buttes and ridges, where the soil, sheltered from the hot afternoon sun, is able to retain more moisture than elsewhere. Below the alpine hemlocks and occupying the middle belt of the mountain is a magnificent forest of Shasta firs; but the humbler vegetation of this belt is scanty and irregular.

From what has been said it is obvious that excessive dryness prevents many of the characteristic zone species from filling their appropriate belts, restricting them to scattered spots, where, as in the desert, succulent vegetation is concentrated about springs and streams. Hence Shasta is a poor place to study the broad general facts of zone distribution, but, as shown later, an admirable place to study detailed effects of slope exposure and humidity.

GLACIAL BASINS.

As in most parts of the Sierra and many parts of the Cascades, glacial basins are conspicuous on the higher slopes of the mountain. They occupy the deep depressions between the radiating ridges, and their terminal moraines are usually clearly defined. In some of the valleys, as along the upper part of Squaw Creek, two or three such moraines may be found at intervals, marking successive stages in the retreat of the glacier. The glacial basins usually contain small streams, at least during spring and early summer, and they receive additional moisture from the melting snows, which linger long in the shadows of the ridges. This moisture permits the growth of a more abundant vegetation than occurs elsewhere on Shasta, save only along the streams. The bottoms of the basins therefore are usually carpeted with red heather (*Bryanthus* or *Phyllodoce empetriformis*) and a variety of small plants, the majority of which are inconspicuous except when in flower. Among the most noticeable of these, each contributing its mite to the general verdure of the heather beds, are the dwarf huckleberries, white alpine auten-

narias, silenes and ligusticums, yellow monkey flowers, violets and hieraciums, blue veronicas and asters, cream-colored feathery lutkeas and parnassias, pink epilobiums, red alpine laurels, and scarlet painted cups.¹ True grasses are scarce, but grass-like carices abound.

The mammals inhabiting the heather meadows are the rare alpine phenacomys (*Phenacomys orophilus*), the white-footed mouse (*Peromyscus gambeli*), the long-tail mountain vole (*Microtus mordax*), and the Sierra pocket gopher (*Thomomys monticola*). The gophers throw up their characteristic mounds about the edges of the heather beds but are commoner on the adjacent pumice slopes.



FIG. 9.—Glacial meadow at head of Squaw Creek.

CANYONS.

All the canyons of Shasta radiate from the ice-covered summit and take remarkably straight courses down the steep sides of the mountain. Most of them are profound gorges cut by swift-flowing glacial

¹ The plants of the glacial basins in the timberline region vary somewhat with the moisture of the soil. The commonest species in moist spots and along the borders of the streamlets are: *Arnica merriami*, *Castilleja miniata*, *Epilobium claratum*, *Hieracium gracile*, *Hypericum anagalloides*, *Mimulus implexus* (growing in the water), *Mimulus primuloides*, *Mitella pentandra*, *Parnassia californica*, *Veronica cusicki*. The commonest species in the drier parts of the heather beds are: *Antennaria media*, *Castilleja miniata*, *Hieracium gracile*, *Kalmia glauca microphylla*, *Lutkea pectinata*, *Ligusticum grayi*, *Phyllodoce empetrifomis*, *Sibbaldia procumbens*, *Silene grayi*, *Vaccinium cespitosum*, *Viola purpurea*.

streams. They average about a thousand feet in depth, and their slopes are as steep as permitted by the unstable material through which they are cut—usually pumice, gravel, and fragments of lava. Owing to the fact that all of the great glaciers are on the north, east, or southeast sides of the mountain, the canyons made by their rivers are necessarily on these sides also. The only one of any size which does not come from a glacier is Diller Canyon, on the west side of Shastina.

In most, if not all, cases the bottoms of the canyons in their upper courses are bridged for long distances by masses of ice and snow—the dumps of avalanches. Below these snow bridges are vast accumulations of loose stones, which in several instances, as in Brewer, Bolam, and Whitney canyons, are piled up in a curious manner. During periods of high water the rocks that fall in are carried down by the torrent and deposited on each side in banks several feet high, so that the traveler on reaching the bottom has to climb up over a ridge of loose stones and down again before coming to the stream. These lateral ridges form miniature canyons in the bottoms of the big ones. Most of the canyons have falls several hundred feet high in their upper courses, and some have other falls farther down. Notable falls are found high up in the canyons of Mud Creek, Ash Creek, Bolam Creek, and Whitney Creek. While difficult of access, they are well worth the effort of a visit.

Mud Creek Canyon (pl. 111), the only one likely to be seen by the ordinary visitor to Shasta, is not easy to cross except near the mouth of Clear Creek, which comes into it from the east. Its east bank is a precipitous single slope about 1,000 feet in height. Its west bank, except above timberline, is broken by a forest-covered terrace or bench, and both descents are likewise steep, though less difficult than the opposite side. The canyon of Ash Creek is better timbered and a little less precipitous than that of Mud Creek. The canyons of Bolam and Whitney creeks, like that of the upper part of Mud Creek, are terrific naked chasms, very deep and so steep that in most places the loose material of their sides will not sustain the weight of a man—much less that of a horse—and when disturbed dashes in avalanches to the bottom.

Diller Canyon is peculiar (pl. 11). It is a tremendous gash on the west side of the otherwise symmetrical cone of Shastina, which it cleaves from top to bottom before taking its practically straight westerly course down the rest of the mountain. It is the only canyon on Shastina, the only notable one on the west side of Shasta, and the only one anywhere on the mountain that does not emanate from a glacier. Its stream comes from enormous banks of perpetual snow.

While the upper parts of the canyons are exceedingly steep and barren, and practically devoid of vegetation, the middle and lower parts are invaded by the trees of the adjacent slopes, and in marshy and springy spots contain patches of willows, alders, and a multitude



SOUTHEAST SLOPE OF SHASTA, SHOWING CANYONS OF MUD AND CLEAR CREEKS.
(KINDNESS OF J. S. DILLER.)

THE HELIOTYPE PRINTING CO., BOSTON

of smaller plants. These places, in Mud Creek and Ash Creek canyons, are the homes of the mountain showt'l or sewellel (*Aplodontia major*), a curious bob-tailed rodent resembling a large muskrat, which lives in a labyrinth of subterranean passages in wet ground, and cuts and drags to its burrows bundles of coarse plants on which it feeds. Weasels (*Putorius arizonensis*) are usually found in the aplodontia colonies and it is safe to assume that their presence there is the most serious factor in the life of the rightful owners of the land.

STREAMS.

The streams that come from glaciers are rapid, turbid, and muddy, and have cut deep V-shaped canyons down the steep slopes of the mountain. Those that come from melting snow are clear as crystal



FIG. 10.—Heather meadow on upper Squaw Creek, showing concentration of vegetation near stream.

and usually flow on the surface or in shallow channels hardly more than a foot or two in depth. They are smaller and less constant than those from the glaciers, and in times of high water carry so much gravel and pumice that they often block their own shallow channels and overflow, cutting new courses near the old ones. During the fluctuations incident to the irregular melting of snow they often reopen the older channels and at the same time retain the new, so that on the higher slopes it is not unusual for a mountain rivulet to occupy several beds at the same time. These are commonly separated by intervals of a few feet or a few rods, and the spaces between are often covered with patches of red heather, dotted with flowering plants of many kinds.

The banks of the more permanent streamlets are so well supplied with moisture that the heather and other plants, often mixed with alpine mosses,¹ form a sod which, growing thicker each year, gradually comes to overhang and finally bridge the swiftly running water. Even away from these sod bridges, which for long distances completely hide the water, the space between the constantly protruding banks is so narrow that only the middle part of the stream can be seen.

The icy rivulets abound in cascades, miniature waterfalls, and crystal pools, bordered by overhanging banks of moss, heather, and dwarf alpine laurel, and adorned by the waving heads of the scarlet painted



FIG. 11.—Miniature cascade on upper Squaw Creek, frequented by water shrews and onuzels.

cupps and cream-colored parnassias. They are ideal homes for the water onuzel (*Cinclus mexicanus*), the large water shrew (*Neosorex navigator*), and the mountain vole (*Microtus mordax*). The latter animal is particularly abundant, and its dark burrows, almost hidden among the plants, may be found opening out on the vertical overhanging banks only a few inches above the water, so that whenever the occupants come out they may plunge in the icy stream before proceeding on their journey. Minks occur lower down along the streams, and still lower, otters.

¹The prevailing moss on the banks of the alpine streams is *Aulacomnium androgynum*.

ROCK SLOPES.

The whole upper part of the mountain between the glaciers and snow banks above and the forest belt below consists of bare rocky slopes, broken at intervals by precipitous cliffs and small heather meadows. The slopes are largely pumice sand, strewn and mixed with fragments of gray volcanic rock, among which the individual plants are so scattered as to disappear in the general view.¹ White-footed mice (*Peromyscus gambeli*) are common on these slopes, feeding on seeds of *Polygonum newberryi* and other timberline plants. Pocket gophers (*Thomomys monticola*) occur here and there and throw up their characteristic mounds in the pumice sand between the rocks. They subsist on the tough roots



FIG. 12.—Characteristic rock slope on north side of Shastina.

of alpine plants, and were observed at intervals up to an altitude of 9,000 feet. The pika or rock cony (*Ochotona schisticeps*) inhabits steep rock slides at distant points around the peak, and lays up stores of plants for winter use. Another mammal inhabiting the rock slides

¹ The commonest plants of the bare stony pumice slopes are: *Agoseris monticola*, *Antennaria media*, *Arabis platysperma*, *Chamaecrista nevadensis*, *Chrysothamnus bloomeri*, *Cymopterus terebinthinus*, *Eriogonum polypodium*, *E. pyrolaefolium*, *Erigeron compositus trifidus*, *Hulsea larseni*, *H. nana*, *Lutkea pectinata*, *Lupinus 'ornatus'*, *L. lyalli*, *Pentstemon menziesi*, *Phlox douglasi diffusa*, *Polygonum newberryi*, *P. shastense*, *Saxifraga tolmiei*, *Senecio canus*, *Silene grayi*, *S. suksdorfii*, *Spraguea umbellata*, *Streptanthus orbiculatus*, and *Viola purpurea*. Besides these, several ferns occur very sparingly on the rock slopes. These are *Dryopteris aculeata scopulina*, *Cystopteris fragilis*, *Cheilanthes gracillima*, and *Paegopteris alpestris*.

and cliffs, but for some unaccountable reason even rarer than the cony, is the bushy-tailed wood rat or pack rat (*Neotoma ciuea*), which, if my memory serves me correctly, is less common on Shasta than on any other mountain I have visited in the West. The mountain chipmunk (*Eutamias amoenus*) and golden ground squirrel (*Callospermophilus chrysodeirus*) inhabit the tongues of pines on the ridges, and not infrequently live in burrows among the bare rocks. Marmots, it is safe to assert, are altogether absent. We completely encircled the peak in the neighborhood of timberline, and examined innumerable ledges and rock slides, such as on other mountains are inhabited by marmots, but without finding so much as a track or sign or even a bleached bone to indicate that any member of the genus *Arctomys* had ever inhabited Shasta. In former days the bighorn (*Ovis canadensis*) was common here, but now the occasional fragment of a skull or the scattered parts of a skeleton are all that remain. In fall the old bucks of the Columbia black-tail deer wander up on the higher ridges. Here and there, particularly in the shelter of the prostrate white-bark pines, tracks and dung of rabbits were seen, but in spite of all our efforts no member of the party succeeded in finding a rabbit on the mountain. The species is probably the Sierra rabbit (*Lepusklamathensis*), though from the large size of some of the dung pellets I was inclined to suspect the presence of *Lepus campestris*.

AVALANCHES.

During the loosening of the snow in spring, avalanches must be very common on the higher slopes, and it is probable that they exert a controlling influence in determining the timber areas above the limit of continuous forest. Nothing forces itself on the observation more firmly than the peculiar way in which the white-bark pines are restricted to the long radiating ridges where they form narrow tongues, separated by broad intervals of steep slopes and basin-shaped valleys. While it might be hazardous to assume that the absence of trees from these extensive slopes and basins is due mainly to avalanches, the fact remains that the tracts they occupy along the tops and upper slopes of the ridges are entirely out of reach of these resistless engines of destruction.

Now and then, however, an avalanche, taking an unusual course, reaches the outskirts of one of these tongues of alpine pines and snatches up and carries below all that lie within its path. This is evident from the weathered trunks and roots often found at the bottoms of slopes where trees have never grown.

The most conspicuous path of a recent avalanche observed is on Cold Creek, between the deep canyons of Mud and Ash creeks (fig. 13). Here an avalanche of unusual size must have shot down the higher slopes until it reached the upper edge of the continuous forest of Shasta firs, where, instead of stopping, it cut a broad swath through the huge trees, tearing them up by the roots or snapping them off and carrying

them on over an almost level tract with such resistless force that the few now left standing are deeply scarred at a height of 10 to 15 feet above the ground, showing where they were struck by other trees in passing over the deep snow. Hundreds of huge trunks 75 to 100 feet long and 3 or 4 feet in diameter are strewn in desolate confusion over the broad area that marks the place where this terrific avalanche slowed up and finally stopped. The accompanying illustration shows a part of this area, and also the gate cut by the avalanche when it struck the upper edge of the forest.



FIG. 13.—Track of avalanche invading forest of Shasta firs on Cold Creek, east side of Shasta.

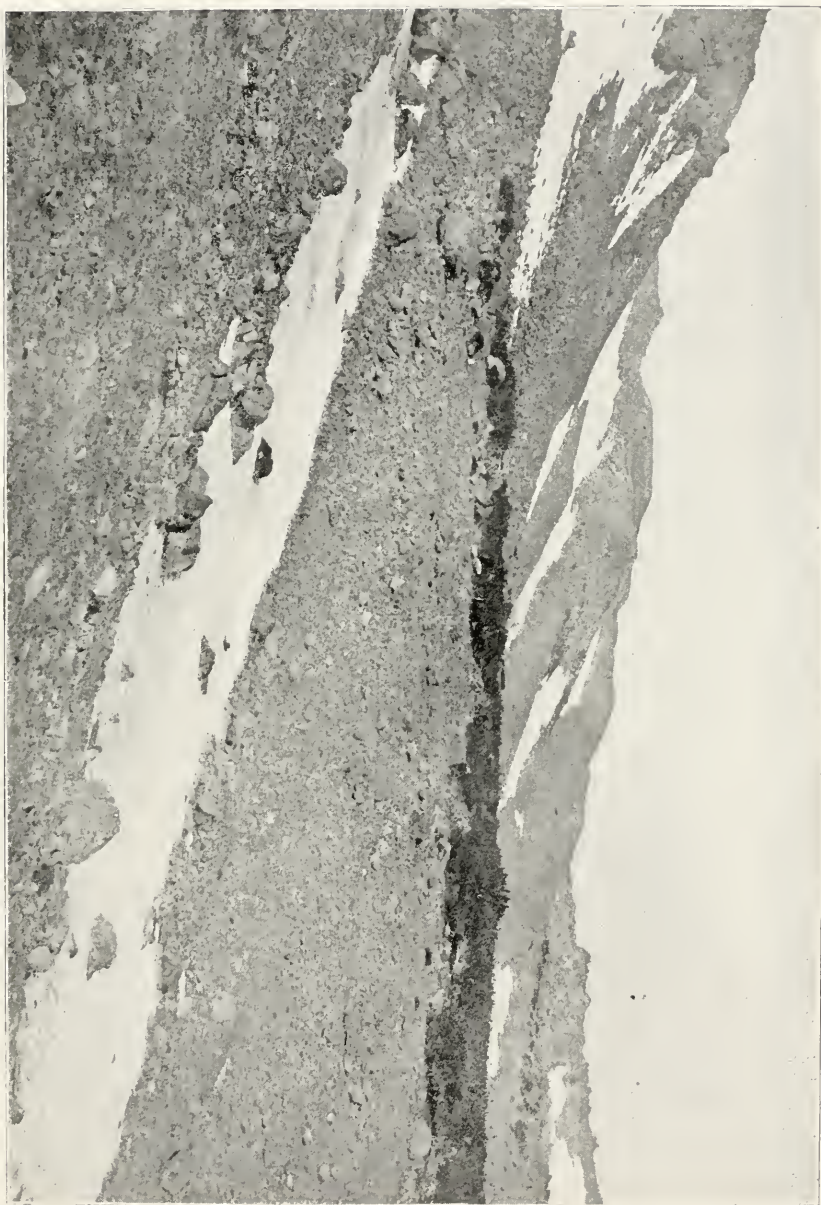
TIMBERLINE.

Timberline is the upper or boreal limit of tree growth, as determined by temperature. It varies somewhat according to the particular species of tree, for even Hudsonian species differ in the degree of cold they are able to endure. Thus in the northern Cascades where the alpine hemlock and alpine fir are the dominant timberline trees, the fir pushes up to higher altitudes than the hemlock. So on Shasta, where the alpine fir is replaced by the white-bark pine, the latter is the true timberline tree and always attains higher elevations than the hemlock.

Theoretically, nothing is easier than tracing timberline on a mountain whose upper slopes are bare or dotted with alpine flowers and whose middle slopes support a continuous forest. Yet on Shasta, and on most high mountains, it is exceedingly difficult to fix the boundary of timberline or indicate its exact position on a map. Of course, it is

possible to follow the uppermost trees wherever they may lead, but a map showing such a route would resemble a saw from which alternate teeth had been removed, the remaining teeth indicating the way the dwarf trees push up on the summits of ridges, the broad spaces between the teeth, the treeless gaps, usually the intervening valleys or basins. Trees always occur at some point in the bottoms of these valleys, and usually extend completely across them, but at an altitude a thousand feet or more lower than that reached on the ridges, and there is a material difference in the trees themselves. If of the same species, those in the valleys are much larger and taller; if of other species, as is frequently the case, they belong to the upper part of the belt below—the middle forest belt. On Shasta, the trees that push up highest on the ridges are always the dwarf white-bark pines, while as a rule those that bridge the intervening valleys below are full-grown alpine hemlocks or Shasta firs, the upper limit of which must not be mistaken for timberline. The difficulty lies in determining what ought to be considered true timberline, and the reason why in the absence of obvious barriers the white-bark pines do not fill more than a third or a fourth of the belt to which they properly belong. If a mountain could be found whose upper slopes form a true cone instead of a series of alternating ridges and valleys, so that successive transverse sections would be circular in outline, instead of irregularly scalloped, it is probable that timberline would form almost a true circle around the peak, rising a little on the southwest and dipping down a little on the northeast. But in the absence of such ideal conditions, actual visible timberline is usually confined to the borders of the tongues of dwarf trees that occupy the summits of the radiating ridges (pl. IV). The explanation of the absence of trees from the intervening valleys is not always easily found; still, if the valleys are studied with reference to the details of their several slope exposures and other local conditions, the position of the hypothetical timberline, in most cases, will be obvious. Let us take, for instance, one of the numerous glacial basins on the south side of Shasta, bordered on each side by lofty ridges which are capped by tongues of white-bark pines. The bottom of the valley, whenever its axial slope is steep enough to be regularly swept by avalanches, can not, of course, contain trees. The broad basin slope of the ridge on the west faces east and is in its own shadow in the afternoon; as a consequence it is too cold for trees, but is well sprinkled with alpine plants. Its summit is covered with dwarf white-bark pines, which come up from the other side and end abruptly along its eastern crest. The cold eastern slope is, in its zone position, actually above timberline, although the tongue of dwarf trees along its crest may stretch up a thousand feet above the lowest alpine plants.

On the opposite or eastern side of the basin the slope faces west or southwest, and receives the warm rays of the afternoon sun. The



TONGUE OF DWARF WHITE-BARK PINES AT EXTREME UPPER LIMIT OF TIMBERLINE.

(Kindness of J. S. Miller.)

result is that this slope, unless too steep or otherwise unsuited to tree growth, or within the track of avalanches, is commonly covered with white-bark pines. As a rule the timbered area on these westerly slopes takes the form of a broadening tongue, beginning at the highest altitude attained by trees on the crest of the ridge and increasing in width at lower altitudes until the bottom of the valley is reached and skirted, and the limit of avalanche movement passed, when the trees again strike out boldly. The pines in the basins are much larger and more erect than those on the summits of the ridges; they decrease in size with increase in elevation. The long oblique line which on the west side of each ridge marks the lower limit of tree growth commonly



FIG. 14.—High timberline ridge, showing effects of slope exposure. The dark patches on the left (west) side of the ridge are dwarf white-bark pines. (Photographed by John H. Sage.)

marks also the upper limit of the area in shadow during the late afternoon. In local spots other factors may account for the absence of trees. Thus, they are always absent from the avalanche-swept bottoms of the valleys, and from ground kept wet by springs or melting snow. Studied with these facts in view, comparatively few treeless areas will be found which can not be explained, and the position of true timberline may be fixed with some degree of certainty. This is really a very important matter inasmuch as it affects the zone position of a great many species.

It is necessary to remember that the reason trees are absent from the cold east and northeast slopes of the ridges whose summits are

covered with dwarf trees is that these slopes are in their zone position truly alpine and above timberline, as already explained.

Nothing is easier than to refer to the wrong zone species found in the treeless basins between the pine-covered ridges. But when it is understood that parts of each basin, regardless of the distance below the highest tongue of timber, are unquestionably *above* timberline (and consequently *Alpine*) and that other parts, regardless of the distance above the nearest trees in the basin, are unquestionably well *below* timberline (and consequently *Hudsonian*), mistakes of this kind will be less frequent.

THE FORESTS OF SHASTA.

Shasta rises from a forested region (pl. v), and the mountain itself is continuously forest-covered up to an altitude of 7,500 or 8,000 feet. The trees of the lower slopes are those of the surrounding region, but those of the middle and upper slopes belong to such widely different species that it is necessary to divide the mountain forest into three belts, which, from their most distinctive trees, may be designated (1) the lower or yellow-pine belt; (2) the middle or Shasta fir belt, and (3) the upper or white-bark pine belt. It is interesting to observe that these forest divisions, as shown later, coincide with the three Life zones—the Transition, Canadian, and Hudsonian.

(1) The Lower Belt or Belt of Yellow or Ponderosa Pines (*Pinus ponderosa*).

The most abundant and characteristic tree of the lower slopes and surrounding region is the yellow or ponderosa pine, which forms a continuous open forest up to an altitude, on the south and west sides, of about 5,500 feet. The only material gap in the pine belt of the mountain proper is a strip about 8 miles in length on the cold northeast quadrant, which is occupied by lodge-pole pines belonging to the zone above (Canadian zone).

On the south and west the open pine forest of the basal slopes is interrupted by extensive parks, which from a distance appear to be meadows of waving grass. A nearer view shows this to be an illusion, the broad fields of green being in reality impenetrable thickets of chaparral—a chaparral of unyielding manzanita and buck brush (*Arctostaphylos patula* and *Ceanothus velutinus*, see fig. 15).

Northwest of Shasta the yellow-pine forest is interrupted by the open plain of Shasta Valley, which on the southwest ends abruptly at the town of Edgewood. North, northeast, and east of Shasta the ponderosa pine forest continues with unimportant interruptions to Devils Garden, Goose Lake, and the Madeline Plains; on the south it is practically continuous to the base of Lassen Butte, and thence along the flanks of the Sierra for 350 miles; on the southwest it follows the canyon of the Sacramento River to a little below Delta, where, in the bottom of the canyon and on its warmer slopes, the curious digger pines of the Upper Sonoran zone mix with and soon replace the ponderosa pines



PINE FOREST AT WEST BASE OF SHASTA
Showing yellow and sugar pines.

of the Transition zone. On the cooler and higher canyon slopes and adjacent foothills the ponderosa pines continue to the border of the Sacramento Valley. West of Shasta they cover all but the highest elevations of the Scott Mountains, completely surround Scott Valley, and reach up a considerable distance over the east arm of the Salmon Mountains, where, mixed as usual with Douglas firs, incense cedars, and sugar pines, they fill the Transition zone. Still farther west they occur in greater or less abundance in the valleys of Russian Creek, North and South forks of Salmon River, Trinity River, and Klamath River, and at appropriate altitudes on the west arm of Salmon Mountains, Trinity Mountains, and the mountains between Hoopa Valley and Redwood Creek. Hence the Shasta forest of ponderosa pines is



FIG. 15.—Manzanita chaparral on south slope of Shasta.

directly continuous—either broadly or by narrow and tortuous tongues—with corresponding forests of southern Oregon, northeastern California, northwestern California, and the flanks of the Sierra.

The ponderosa pines of the Shasta plateau and adjacent region are peculiar—peculiar in the extent of their variability—and deserve careful study. Not only do the cones of adjacent trees present an unusual degree of variation in size and compactness (particularly noticeable in Scott Valley), but the cones of trees subjected to apparently slight differences of temperature, moisture, and soil present certain average differences that are quite surprising. Moreover, on higher parts of the Scott Mountains, and also along their cool east base, fairly typical *Pinus jeffreyi* grows within a short distance of *ponderosa*. Whether or

not the two actually intergrade, while an interesting question, is of little consequence compared with the fact that here, as in the Sierra, the two trees occupy adjoining but distinct belts—*ponderosa* the warmer and normally the lower; *jeffreyi* the colder and normally the higher. It sometimes happens, however, as in places along the cold east base of the Scott Mountains, where local conditions produce abnormal temperatures, that a strip of Jeffrey pine is sandwiched in between two areas of ponderosa pine. In this instance the low temperature comes in part from the cooling effects of cold streams, and in part from the afternoon shadows of the mountains.

The ponderosa forest is nowhere pure over any large area, but is sprinkled in varying proportion with sugar pines, incense cedars, Douglas firs, and white firs, and at lower altitudes with black oaks. The stately sugar pines are so valuable for lumber that the best have been already cut, but enough remain to show that the species was

formerly common in most parts of the ponderosa forest. The incense cedars also are scattered over the whole region, but the Douglas and white firs require more moisture and consequently are less evenly distributed. They are most abundant on the borders of streams, in cool canyons, and along the well-watered



FIG. 16.—Cones of ponderosa and Jeffrey pines.

east base of Mount Eddy and the Scott Mountains, where they become the dominant trees, the ponderosa pines being comparatively scarce. On drier and warmer soil, away from the cooling influence of the Scott Mountains, the ponderosa pines rapidly increase, and in the area between Black Butte, Shasta Valley, and the mountain, although sprinkled with incense cedars and black oaks, they form the purest ponderosa forest of the region.

Another conifer of the yellow-pine belt is the knobcone pine (*Pinus attenuata*), a narrow interrupted tongue of which pushes up Panther Creek. The deciduous trees of this belt are the black oak (*Quercus californica*), Oregon maple (*Acer macrophyllum*), tree alder (*Alnus tenuifolia*), and Oregon dogwood (*Cornus nuttallii*). The maple and dogwood are restricted to the lowest levels and do not occur in very dry places; the alders are confined to the neighborhood of water; the oak ranges more widely over the lower half of the pine belt and thrives on dry as well as on moderately moist soils.

The conifers will be considered as individual species.

SUGAR PINE (*Pinus lambertiana*).—The sugar pine is the largest, handsomest, and noblest of our western pines, and its wood is so

valuable for lumber that, except in inaccessible places, the best trees have been cut. The huge trunks, often 6 or 7 feet in diameter, rise as straight symmetrical pillars to a height of 150 or 200 feet, and are covered with fine beautiful bark. The long and graceful branches are usually confined to the upper parts of the trees, and the cones they carry are the longest known, frequently attaining a length of a foot and a half and sometimes of 2 feet. They are very light, however, and when falling are by no means so dangerous to the passer below as the shorter and more massive cones of the digger pines.

Around the base of Shasta the sugar pines reach from a point on the northwest slope about $4\frac{1}{2}$ miles southeast of Edgewood, near the south end of Shasta Valley, southerly and westerly all the way around to Ash Creek, where they cease at an altitude of about 5,000 feet. They are fairly common in McCloud Valley and at Sisson, whence they extend south along the Sacramento Canyon to 'The Loop.' They are at present more abundant in the neighborhood of Black Butte than elsewhere about the mountain. In the Shasta region they are not so large as on the west slope of the Sierra in central California; still the stump of a sugar pine measured by me in McCloud Valley was 7 feet 7 inches in diameter 6 feet above the ground.



FIG. 17.—Knobcone pine on Panther Creek.

KNOBCONE PINE (*Pinus attenuata*, fig. 17).—The knobcone pine is a tree of erratic distribution. On Shasta it is confined to the lower slopes on the south side, from Panther Creek easterly to a point between the branches of Mud Creek, where it ranges irregularly from an altitude of 3,800 up to 5,600 feet. The latter limit is attained in a gully a little east of Wagon Camp, in a continuation of the Panther Creek strip. Lower down on Panther Creek, where the original forest of ponderosa and sugar pines has been removed by the combined work of lumbermen and forest fires, and the slopes are now covered by an impenetrable jungle of manzanita, this singular pine remains, com-

monly growing in narrow lines. The trees are rarely more than 50 feet in height, and most of them are much smaller. They bear a marvelous load of slender curved cones, which on the limbs grow close together in whorls or rows, and on the trunks are scattered or grow in circles. They remain on the trees for many years, as in the case of few other species, and their large size, extraordinary numbers, and peculiar arrangement give the tree a singular and unusual appearance.

Vernon Bailey has given me the following note on some knobcone pines examined by him on Panther Creek, September 27, 1898:

The trees were loaded with cones, in whorls of three to seven around the branches, and down the trunks to 10 or 12 feet from the ground. Some of the cones must have been 20 or 30 years old, and perhaps much older. I cut off a lot of the old lower cones to see if the seeds were good, and put them on a bowlder and cracked them with a few hard blows of the ax. All of them were full of worm dust, with only now and then an undiscovered seed or a fat white worm. Cones of medium age (5 or 6 years back from the end of the branch) were invariably occupied by worms and worm dust, and usually contained few good seeds. Cones only 1 or 2 years old were rarely wormy. A great many of the old cones had been dug into by woodpeckers, either for seeds or, more likely, for the fat white grubs that live on the seeds. The cones are too hard to be broken or split apart by the woodpeckers, and are opened by a smooth hole drilled into the middle, or sometimes to the opposite wall. Usually the opening is long and narrow. Sometimes the whole inside of the cone has been drilled out, leaving only the shell; sometimes a small round hole has been drilled just through the outer shell.

WHITE FIR (*Abies concolor lowiana*).—The white fir ranges from Sisson, at the bottom of the west slope of Shasta, up to the lower edge of the Shasta fir belt, which it slightly overlaps. At Wagon Camp (fig. 1, alt. 5,700 feet) both species are common. The white fir requires more moisture than the other conifers of the lower timber belt, and consequently its distribution is discontinuous. It is most abundant along the well-watered eastern base of Mount Eddy, north of Sisson. The highest elevation at which it was observed is a warm ridge on the east side of Mud Creek Canyon, between the mouths of Mud and Clear creeks, where, with a number of other Transition zone species, it occurs at an altitude of 6,700 to 7,000 feet. This is 1,000 feet above its usual limit, and its presence here is due to the angle and steepness of the slope, as explained elsewhere (p. 49).

Abies lowiana is easily distinguished from *A. shastensis* and *A. magnifica* by the bark, which is very thick and deeply furrowed, so that it resembles that of Douglas spruce (*Pseudotsuga mucronata*) much more closely than that of the other *Abies* of the region. The cone scales are broad and rather short, and the bract is short and tricuspidate (fig. 19).

DOUGLAS FIR OR SPRUCE (*Pseudotsuga mucronata*).—Douglas fir is scattered irregularly through the ponderosa pine forest. Like the white fir, it prefers a moister soil than suits the ponderosa pines, and therefore thrives best in the gulches and near the streams. Thus along the cool well-watered east base of Scott Mountains the forest consists mainly of Douglas and white firs, with scattered incense cedars and sugar

and ponderosa pines, while on the drier ground a little farther east the pines increase and the firs decrease or disappear. Most of the larger trees on the south and west slopes have been cut for lumber. A stump near McCloud Sawmill measures, at 6 feet above the ground, 8 feet in diameter.

INCENSE CEDAR (*Libocedrus decurrens*).—The incense cedar occurs in greater or less abundance in all parts of the ponderosa forest, on both dry and wet ground, and from the bottom of the valley at Sisson



FIG. 18.—Incense cedar on south slope below Wagon Camp.

up to the edge of the Shasta firs at Wagon Camp. But it is commonest near the cool east base of the Scott Mountains. In moist places the trees often grow in groups, but in the dry forest they are usually scattered at intervals among the pines. On Shasta the bark of the cedars is generally smooth and free from scales, except on the very youngest trees. In the more humid area between Scott Mountains and the coast the scaly bark persists for many years, so that the trunks of middle-aged trees look very different from those of corresponding size in the dry interior.

(2) **The Middle Belt or Belt of Shasta Firs** (*Abies shastensis*).

Above the forest of ponderosa pines, and therefore not connected with similar forests elsewhere, a belt of Shasta firs averaging 2 or 3 miles in breadth and 2,000 feet in vertical range completely encircles the mountain. It is the distinctive forest of Shasta—a forest of tall stately trees, dark, somber, and free from underbrush, though here and there beds of the low mountain manzanita (*Arctostaphylos nevadensis*) afford a pleasing relief from the uniform dark brown of the surface carpet—usually a shallow layer of fir needles mixed with decayed cones and wood. The massive trunks, which on the steep slopes are often swollen just above the ground to give greater strength to resist the pressure of snow, average from 4 to 6 feet in thickness and some attain a diameter of 7 or 8 feet. Above the level of winter snow their northern sides are usually covered with the handsome bushy yellow lichen, *Erernia vulpina*, which also clothes many of the branches; and in the denser parts of the forest the trees are draped with pendant masses of the long black-beard lichen, *Alectoria fremonti*. The forest almost everywhere consists of large mature trees, and is free from evidences of fire; but in one place, between Mud Creek Canyon and Cold Creek, a considerable area, evidently an old burn, is covered with young trees averaging perhaps 20 feet in height.

As a rule, the Shasta firs stop abruptly where the white-bark pines begin, and trees at their upper normal limit are of full size. But now and then on the steep and relatively warm southwesterly slopes of the ridges, dwarf Shasta firs occur. The highest point at which such were observed was at an altitude of 8,900 feet on the east rim of Mud Creek Canyon, where a few stunted trees 3 or 4 feet in height were found mixed with white-bark pines. On a similar warm slope west of Squaw Creek a scattered line of these trees was noted at an altitude of 8,100 to 8,300 feet. Here the largest were 20 feet in height. Their bark differed materially from that of trees lower down, being pale grayish instead of dark brown, and thin, smooth, and full of blisters, instead of thick and deeply furrowed. These fir trees were mistaken for another species until I had the good fortune to find a few bearing cones, which, on August 1, were two-thirds or three-fourths grown. To my surprise, they had long exserted bracts which, as in the young cones, stood straight out horizontally. Very young cones (2 to 3½ inches long) always appear to consist of bracts alone, the scales being hidden inside. On breaking open the cones the tiny scales are seen encircling the axis; they are less than half the size of the bracts and occupy the inner half of the diameter or section of the cone.

The normal bark of the Shasta fir resembles that of the alpine hemlock. It is rather regularly furrowed vertically, and the plates between the furrows are cracked horizontally, so that it suggests that of the ponderosa pine, though the plates are smaller and less red. Along the lower edge of the Shasta fir belt the bark is darker and the cracks and furrows are narrower.

The upper edge of the Shasta fir belt meets the alpine hemlocks and white-bark pines of the belt above; the lower edge the ponderosa pines, incense cedars, Douglas spruce, and white firs of the belt below. The firs are easily distinguished by bark, branches, and cones. The Shasta fir has very dark and relatively thin bark, regularly furrowed so as to form 'plates' like those of the ponderosa pines, only smaller, narrower, and transversely cracked. The branches are irregular, droop at first (from the weight of winter snow), and then curve upward, and the branchlets are small and terete, and stand out with mathematical precision; the cones are huge, and their green, tongue-like, single-pointed bracts protrude far beyond the scales, as in the noble fir of the northern Cascades. In young cones the bracts stand out straight; in old cones they are strongly deflexed. The white fir (*Abies lowiana*) has much thicker and grayer bark, deeply furrowed at base and not forming regular scales or plates; the branches are more regular and more nearly horizontal, the branchlets flatter, more spreading, and lacking the mathematical lines of the Shasta fir; the cones are more slender, and the tricuspidate bracts are short, reaching less than half-way across the scale. The cone-scale differences are shown in the accompanying diagrams. (See fig. 19.) The year 1898 was an 'off year' for cones, but plenty of old scales were found on the ground, and broken cones were discovered in holes in logs, where they had been carried by pine squirrels.

The Shasta fir forest is mainly pure, but in places, particularly on the east and northeast sides of the mountain, silver pines are scattered through it, and in one place along its lower border (between Ash and Inconstance creeks) the firs are replaced by lodge-pole pines, the only ones on the mountain.

Whether or not *Abies magnifica* occurs on Shasta is a question on which we can throw no light. I do not know how to tell *magnifica* from *shastensis* except by the cones, and the trees did not bear cones the year of our visit.¹ Still, we found great numbers of old cones tucked away by the squirrels in decayed logs, and disconnected scales under most of the trees where search was made, and among all these failed to find a single bract which was not strongly exserted. And yet Miss

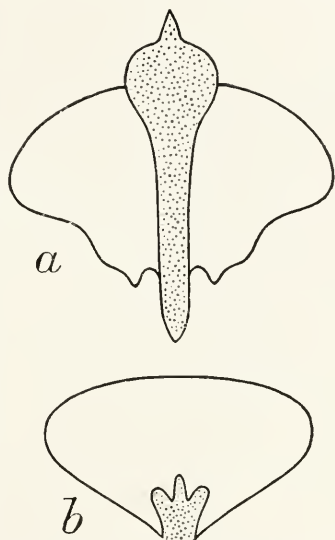


FIG. 19.—Cone scales of (a) *Abies shastensis* and (b) *Abies concolor lowiana*.

¹ While this paper was passing through the press (July, 1899), Walter K. Fisher revisited Shasta. He found the firs heavily laden with cones, and although thousands of trees were examined he failed to find a single cone without the exserted bracts.

Alice Eastwood showed me, in the herbarium of the California Academy of Sciences, a cone, said to have come from Wagon Camp, in which the bracts, except a few at the base, are not exerted.

SILVER PINE OR MOUNTAIN WHITE PINE (*Pinus monticola*).—Silver pines occur here and there on Shasta, scattered among the Shasta firs. They were found in greatest abundance on a pumice slope south of Brewer Creek Canyon, where they are the dominant trees up to an altitude of 7,200 feet, and where the ground was strewn with cones of the previous year—cones in which the scales are strongly reflexed.



FIG. 20.—White-bark pine (*Pinus albicaulis*).

In this area, along Brewer Creek, they meet and slightly overlap the alpine hemlocks and white-bark pines of the zone above. They are common also on the steep lava ridges on the north side of Shasta, particularly in the neighborhood of Inconstance Creek and in Mud Creek Canyon, especially on the west side of the ridge between Mud and Clear creeks. A few trees occur near the top of Red Cone, east of Wagon Camp.

LODGE-POLE PINE (*Pinus murrayana*).—The lodge-pole pine was not found on Shasta except on the northeast quadrant, where Ver-

non Bailey, in following the wagon road around the mountain, passed through a belt of it about 8 miles in length. It begins 3 miles northeast of Ash Creek at an altitude of about 5,400 feet and reaches northerly to about 3 miles northwest of Inconstance Creek, where it ends abruptly at an altitude of 5,600 feet. Here it is the dominant tree, and in half of it the only tree. This area is covered during the latter part of the afternoon by the shadow of the mountain, and consequently is colder than places of equal altitude farther north or south. The soil is sandy and barren and the trees are of small size.

(3) The Upper Belt or Belt of White-Bark Pines (*Pinus albicaulis*).

Still above the forest of Shasta firs, braving its way upward over the bare rocky ridges into the very teeth of the domain of perpetual snow, is another timber belt—an open belt of straggling, irregular trees, whose



FIG. 21.—Dwarf white-bark pines on a high ridge.

whitened, twisted trunks with their storm-beaten heads of green are among the most weirdly picturesque objects on the mountain (fig. 20). The tree is the timberline white-bark pine, which, wherever found, pushes its way over steep and barren slopes to the extreme upper limit of tree growth.

At the lower part of its range it forms an almost continuous though narrow belt around the mountain, and often attains a height of 30 or 40 feet and a diameter of 2 feet. In the higher parts of its range it soon becomes restricted to the ridges, leaving the intervening basins and gulches bare, and as it climbs higher and higher becomes more and more reduced in size and undergoes material changes of form and position. At certain altitudes the slanting trunks, only 4 or 5 feet in height, serve as pillars to support the flattened tops which form a canopy of intertwined and matted branches (fig. 21).

These dwarf groves offer attractive shelters from wind and storm, and we usually camped among them when working the upper slopes.

The tree is one of exceptional hardihood, and as it pushes on still farther into the realm of cold the trunks become completely prostrate and the branches hug the ground, forming among the rocks dense mats which sometimes rise a foot or two above the general level, but at their upper limit usually occupy depressions, or, if growing in the lee of a boulder, crouch behind it and continue its surface level to the adjacent slope, as if trimmed to fit. Indeed, one is amazed at the way these uppermost pines avoid exposure by flattening themselves into the hollows, as if afraid to lift a finger above the general level. Their life is a perpetual struggle—not against competing plants, but against a hostile environment. In summer they are buffeted by the winds and pelted by sand and gravel; in spring they are swept and torn by the resistless avalanches, and in winter they are deeply buried under heavy banks of snow. The prostrate trunks in young and middle-aged healthy trees are completely concealed, often half covered by stones and pumice sand, and hidden by the density of their own branches and foliage; but in very old trees, and those injured by passing avalanches or laid bare by the washing away of protecting rocks during violent storms, the trunks are partly exposed and their extraordinary features may be easily examined. As a rule they are not only naked, but the strongly twisted wood, gnarled, contorted, and, ironlike in firmness, has been eaten into by the sand blast till the knots and hardest parts stand out in prominent ridges.

A little below timberline on the north side of Shasta, between North Gate and Shastina, is an extensive gently sloping pumice plain, strewn with fragments of gray shaly lava, and thickly spotted with rather



FIG. 22.—Pumice plain north side of Shasta, showing timberline mats of white-bark pines.

large mats of pines, averaging 2 to 4 feet in height, which give a most curious aspect to the region (fig. 22). This area, which is about a mile

and a half across (horizontally), must contain thousands of acres of the dwarf, flattened pines. Along its lower edge, singularly enough, trees of the same species suddenly stand upright and grow to large size, forming a rather solid forest, perhaps 30 feet in height, with an abrupt front facing the dwarf pines above. The suddenness of the transition is unusual and difficult to explain.

The forest just mentioned is probably the largest continuous area of *Pinus albicaulis* on Shasta. Situated a little below timberline, it stretches, apparently without interruption, from North Gate Buttes to Diller Canyon, a distance of fully 5 miles, thus encircling the north-west quadrant of the mountain, including Shastina.

Perhaps the most attractive grove of white-bark pines on Shasta is one that fills an open gulch or glade on the east side of North Gate Buttes. Here, in the lower part of their belt, the trees are large and uncommonly symmetrical, and the gray pumice soil is covered with silvery lupines. In ascending the gulch the pines gradually decrease in size until at 'The Gate' (alt. 8,500 feet) they are dwarfed and their tops are broadly flattened.

The normal altitudinal limits of the white-bark pines on Shasta are hard to fix. On the south and southwest sides the trees descend in places to 7,500 feet and range thence upward on the hottest ridges to an extreme limit of 9,800 feet. But this extreme altitude is attained at two points only—on the long ridge above 'The [South] Gate' (near Red Butte) and on a ridge about a quarter of a mile west of Mud Creek Canyon. On the west rim of the canyon the pines stop at 9,500 feet



FIG. 23.—A large prostrate tree of white-bark pine, a little below timberline.

and on the ridge on the east side at 8,600. Probably 9,300 to 9,500 would be a fair average for their upper limit on the warmer southerly slopes.

On the cold northeast slope, just south of Brewer Creek, they descend

on a barren pumice slope to 7,000 feet, where, sparingly mixed with alpine hemlocks, they meet the upper limit of Shasta firs and silver pines.

BLACK ALPINE HEMLOCK (*Tsuga mertensiana*¹).—But the white-bark pine, although the dominant and most widely distributed tree of the upper timber belt, is not the only tree, for in places it is mixed with or replaced by the black alpine hemlock. Shasta is a very dry mountain, and yet the white-bark pine thrives on its driest slopes and grows among the bare, naked blocks of lava where tree life seems impossible. The hemlock requires more moisture, and therefore is at a decided disadvantage. It never reaches as high as *Pinus albicaulis* and attains its best development along the lower border of the Hud-



FIG. 24.—Black alpine hemlocks near Squaw Creek.

sonian zone, where it occurs in disconnected sheltered localities—usually in canyons or on the shady east or northeast sides of buttes or ridges, where there is more moisture than on the exposed slopes. Since these shady easterly slopes are always cold, the hemlocks that occupy

¹This is the species heretofore commonly known as *Tsuga pattoni* or *Tsuga pattoniana*. It has been recently discovered that the name *Tsuga mertensiana*, commonly applied to the Pacific lowland hemlock, was first given to the present alpine species, necessitating a most unhappy change of name. Fortunately, however, the common English names of the two and their widely different zone ranges—one restricted to the low Transition belt near the coast, the other to the high Hudsonian zone on the loftiest mountains—may prevent the confusion that otherwise would result from the change of name.

them descend in tongues considerably below the usual lower limit of the belt to which they belong. The most extreme case of the kind observed is on the east side of the series of hills and ridges known on the map as 'Gray Butte,' where a gulch, sheltered from the warm afternoon sun and moistened by seepage from melting snows, carries the hemlocks to a lower altitude than they reach elsewhere. On suitable slopes they usually begin about 7,200 or 7,300 feet and range up to about 8,000 feet. The highest altitude at which they were observed is 8,700 feet, a little east of Mud Creek Canyon, where a few stunted trees were found among the white-bark pines. Their extreme upper limit is thus a thousand feet lower than that of the white-bark pines. This is



FIG. 25.—Group of alpine hemlocks near Deer Canyon.

due, in part at least, to the character of the upper slopes, where no trees can grow except on the ridges—as explained under the head of Timberline (pp. 27-30)—and here the ridges are too exposed and too dry for hemlocks.

On Shasta the alpine hemlock does not grow in such luxuriance or attain such dimensions as in the Cascade Range. The average height of mature trees seems to be 80 or 100 feet; the average diameter a little less than 3 feet. Trunks 4 and 5 feet through are by no means rare and the one shown in the accompanying photograph (fig. 26) measured 6 feet. It is a characteristic habit of hemlocks on sloping ground to grow in clusters, 3 to 7 springing from a common base. In this way, when young, they are better able to withstand the pressure of the snow.

Those that grow singly usually support themselves by having the trunks strongly curved downward just above the ground, as shown in fig. 26.

The alpine hemlock is one of the most picturesque and attractive trees of our western mountains. Its beauty is due in part to the handsome trunks and irregular drooping branches, but mainly to the dense and peculiarly tufted foliage which falls in graceful masses in such manner as to conceal the branches and upper parts of the trunks. The twigs or ultimate branchlets curve upward and the needles stand out on all sides and point outward—away from the body of the tree—producing a tufted appearance very unlike that of other conifers. This

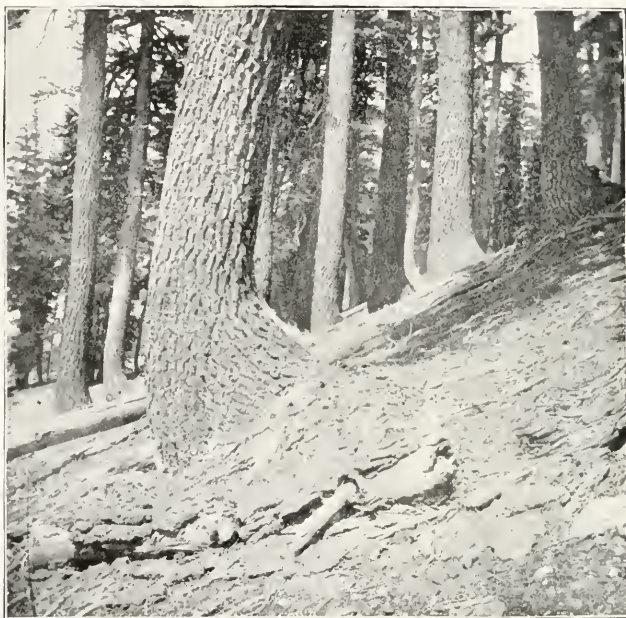


FIG 26.—Trunk of alpine hemlock, showing thickening and curvature of base.

effect is heightened during the latter part of summer by the light green tips of the new growth.

The hemlock forest is dark, somber, and silent, and its drooping branches are draped with the dangling beards of the black-beard lichen (*Alectoria fremonti*). The only color that breaks the otherwise uniform darkness is the bright yellow lichen (*Evernia vulpina*) which covers the north or northwest sides of the trunks and upper sides of the branches—a conspicuous feature and one seemingly out of harmony with the general tone of the forest. In all these respects the hemlock forest accentuates the features of the Shasta fir forest of the belt below, with which it is directly continuous. The tree trunks and bark also resemble those of the Shasta firs. The bark is in long scales which, as

the trees grow, thicken into irregular plates transversely broken at intervals of 8 to 12 inches.

In the growing tree the branches die from below upward in a curious way. First a subdivision of a low branch dies and the tips curl downward and inward, drawing together until they form a close curl or tail which can be set on fire by a single match. Dozens of these curls can be seen on most of the young trees, and also on the lowermost remaining branches of the middle-sized and some of the old ones. This process of dying and curling continues until all the lower branches are dead. Meanwhile, the curl-tails gradually drop off and litter the ground, leaving the bare dead branches hanging down at a sharp angle. These dead branches hug the trunks closer than the living ones and cling on until the bark comes off, when they form an armature of



FIG. 27.—Group of alpine hemlocks.

unsightly bleached and brittle sticks pointing downward around the trunk. These in time break off, too, so that as the tree grows into maturity the handsome trunk finally becomes clear and clean.

The alpine hemlocks are prolific bearers and the ground is always strewn with their cast-off cones, which average about $2\frac{1}{2}$ inches in length, and have a dark streak down the middle of each scale. When young the cones are conical, when old and the scales become fully reflexed they are slender, subcylindrical and only three-fourths of an inch in diameter. Year after year the cones fall to the ground in such prodigious numbers that they form a very important part in the layer of felting that covers the surface in the hemlock forests—a loose dark felting composed of disintegrating needles, twigs, and cone scales pressed firmly together by the weight of the snow in winter, and

only rarely dotted by living plants. In moist spots, particularly along the borders of the tiny sparkling streams, the red heather (*Phyllodoce empetrifomis*) forms little beds and the delicate feathery *Lutkea pectinata* spreads a faint veil of green over the dark soil. In the drier parts of the forest hardly a plant is seen save now and then a solitary clump of prince's pine (*Chimaphila menziesi*) or painted wintergreen (*Pyrola picta*).

Late in September the hemlocks molt and the wind brings down showers of needles that falling on the tent at night sound like rain. Their color has now changed from green to golden brown and they sprinkle the black floor of the forest so thickly as to change its appearance.

FOREST FIRES.

During the past ten years the country about Shasta, particularly on the west and south, has been repeatedly devastated by forest fires. Here, as elsewhere, lumbermen and fires have destroyed the greater part of the timber on the lower slopes and adjacent plain, which are now covered by a dense chaparral of manzanita and buckbrush, dotted with scattered pines. Fortunately, the fires have not as yet spread upward far enough to do much damage to the Shasta firs of the middle timber belt. Whether the character of these trees and the freedom of the ground beneath from combustible material will prevent the spread of fire remains to be seen. Thus far the greatest harm has been done in the forests of ponderosa and sugar pines, where lumbering operations are being carried on with painful vigor.

While we were on the mountain, from the middle of July until the end of September, one or more fires, the result of vandalism or neglect, were raging continuously on the south and west slopes, and two of them did irreparable injury. One began near some woodcutters' shanties, 3 or 4 miles below Wagon Camp, on the road to Sisson; the other and more destructive originated in the area covered by the lumbering operations from McCloud Mill and pushed swiftly up the Panther Creek slope, consuming the greater part of the only area of *Pinus attenuata* on Shasta and burning great tongues into the handsome fir forest on both sides of Wagon Camp, which it closely and almost completely surrounded.

The fire that lasted longest in the summer of 1898 did the least harm. It consumed a worthless tract of manzanita chaparral between Black Butte and the mountain, and gave off a surprisingly enormous quantity of smoke, hiding the country to the west for a full month. During its continuance the entire mountain was often enveloped in smoke and when the wind was northwest, as it was a great deal of the time, showers of burned leaves fell daily at our camps. On August 2, when we were at work on the rocky slopes above the head of Squaw Creek at an altitude of 9,500 feet, charred leaves fell so abundantly that we caught many in our hands. Great clouds of smoke rolled up between us and

the sun, which became deep red like the full moon and then disappeared. At 5 o'clock the smoke began to settle back, as it always did when the chill of the evening came on, and the sun reappeared, to set as usual behind the dark outlines of the distant mountains.

Fires on the south, in the valley of the McCloud, cut off the view in that direction, and it was only at rare intervals, and usually at sunset, that we were able to see the snowy crown of Lassen Butte 60 miles away. Even Castle Crags, almost at our feet, were rarely visible. This experience is frequent in the west; and of the hundreds of persons who visit the Pacific slope every summer to see the mountains, few see more than the immediate foreground and a haze of smoke which even the strongest glass is unable to penetrate.

Along the railroad between the head of Sacramento Canyon and Shasta Valley one traverses desolate tracts which a few years ago were covered by a noble forest of ponderosa and sugar pines.

EFFECTS OF BURNS IN CHANGING ZONE POSITIONS.

A burn in the lower part of the Shasta fir forest a little above Wagon Camp affords an excellent illustration of the way fires sometimes change the zone relations of particular areas. The area in question was well within the Canadian zone before the fire, which occurred only a few years ago. Since the fire, Transition zone species have crept up the ridge, and now *Ceanothus velutinus*, *Arctostaphylos patula*, *Horkelia pseudocapitata*, *Apocynum pumilum*, *Gayophytum ramosissimum*, and others are common. The manzanita and buck-brush are young and small but are spreading, so that in a few years the ridge, which has a warm southerly slope, will be mainly Transition. But in the meantime a new growth of Shasta firs has started, and in ten or twenty years is likely to overtop and drown out the Transition zone species, enabling the Canadian zone to reclaim the burn.

Such cases of alternation of zones resulting from the clearing of forest land are not uncommon, particularly when deforestation is caused or accompanied by fire. But on steeper slopes, especially rock slopes, if the vegetable layer is burned off, the (lower) zone which creeps up to replace the (higher) one destroyed becomes permanent or nearly so.

It may be laid down as a general rule that the destruction of forests, by admitting the sun and wind, lessens the moisture in the soil and increases the temperature, thus inviting animals and plants to come in from adjacent warmer areas. Deforestation of an area therefore tends to lower its zone position.

SLOPE EXPOSURE.

By slope exposure is meant the inclination of the earth's surface at a particular point with reference to the angle at which it receives the sun's rays. The amount of heat, were it not for the retarding effect of

the atmosphere, would be greatest at noon, when the sun's position with reference to the earth is most nearly vertical. But, as everyone knows, the atmosphere becomes heated slowly and does not attain its highest temperature until the middle or latter part of the afternoon, the hour varying with the locality. Hence slopes that face the sun most nearly at a right angle at the time of day when the atmosphere is hottest are naturally the hottest slopes—those that carry the zones highest; while conversely, slopes that face the opposite direction are naturally the coldest slopes—those that depress the life zones lowest. At Portland, Oregon (about 275 miles north of Shasta), the hottest part of the day in summer is a little after 4 o'clock in the afternoon, at which time the sun is nearly due west. Consequently the hottest uncomplicated slopes are those that face west or a little south of west.

The accompanying diagram shows the actual mean hourly march of atmospheric temperature at Portland, Oregon, for June, July, and August:

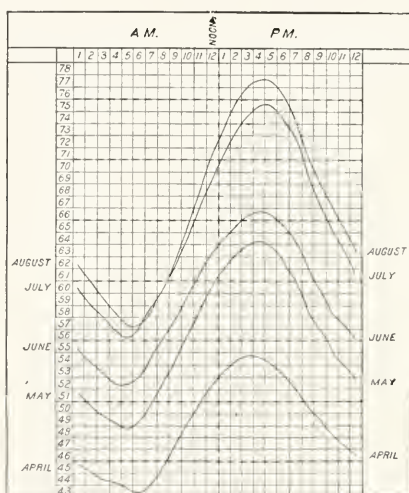


FIG. 28.—Diagram showing average hourly march of temperature.

The influence of slope exposure on the faunas and floras of mountainous regions is profound. Measured by a scale of altitudes, it amounts on ordinary slopes to nearly a thousand feet, and on steep slopes is still more marked. Thus on mountains it is usual for plants and animals of particular species to occur on warm southwesterly slopes at elevations 800 to 1,000 feet higher than on cool northeasterly slopes. Similarly on north and south ridges, the faunas and floras of the warm west slopes often belong to lower zones than those of equal elevations on the cool east slopes.

Shasta affords innumerable examples of the effects of slope exposure, both simple and complicated by canyons.

An excellent illustration of the latter is to be found in Mud Creek

Canyon, near the mouth of Clear Creek (see pl. III). The altitude of the bottom of the canyon at this point is 6,700 feet, which would naturally place it in the middle of the Canadian zone. The steep west side of the narrow ridge between the two creeks receives the afternoon sun at nearly a right angle, and is in consequence an unusually warm slope for the altitude. The result is that seeds of plants carried upward by winds and birds from the Transition zone, more than 1,000 feet below, have here found a favorable resting place and have grown into a colony of Transition zone species, among which are *Abies concolor lowiana*, *Arctostaphylos patula*, *Kunzia tridentata*, *Amelanchier alnifolia*, *Rubus parviflorus*, *Sorbus sambucifolia*, *Symphoricarpos pilosus*, *Ribes viscosissimum*, *R. amictum*, *Sambucus melanocarpa*, *Apocynum pumilum*, *Spiraea douglasi*, *Vaccinium (arbuscula?)*, *Lupinus elmeri*, *Eriogonum marifolium*, *Gilia aggregata*, *Pteris aquilina lanuginosa*, and the large Transition zone form of *Castilleja miniata*. Just across the canyon, and in one place less than 100 feet from the lower edge of this isolated Transition colony and at a lower level, are species belonging to the Hudsonian zone—such as *Pentstemon newberryi* and *Pulsatilla occidentalis*. Thus, growing close together on opposite slopes of the same canyon, are species characteristic of zones both above and below the one to which the altitude properly belongs. This case is by no means peculiar and is a good illustration of the simpler effects of slope exposure commonly shown in mountain canyons.

Another class of cases is found on the buttes and hills. A mile and a half northeast of Wagon Camp is a conspicuous red cinder cone about 1,000 feet in height, known as Red Cone. In zone position it is well within the lower part of the Canadian belt where it is surrounded by the forest of Shasta firs, scattered trees of which push up on the basal slopes and on the south side reach the top. Just below the summit are a few silver pines belonging to the same zone. The warm southwest slope brings up from the Transition zone below thickets of manzanita, a few incense cedars, and several humbler plants. The cold northeast slope, although reaching an altitude of only about 6,800 feet, which would place it in the middle of the Canadian zone, is cold enough to bring down from the Hudsonian zone several characteristic plants, such as *Polygonum newberryi*, *Cymopterus terebinthinus*, *Cycladenia humilis*, *Eriogonum polypodium*, and *Viola purpurea*.

On the south side of Shasta an interrupted ridge or series of buttes, known collectively as 'Gray Butte,' reaches up the mountain side from Red Cone, east of Wagon Camp, northward to the gap known as 'The Gate.' In a gulch or canyon on the east side of this butte the black alpine hemlock descends more than 1,000 feet below its usual lower limit. The reason is obvious. The row of buttes cuts off the warm afternoon sun, and seepage from melting snows keeps the soil moister than in more exposed places, so that the gulch meets the two requirements of the alpine hemlock—a moist soil and a cold atmosphere. For its entire length this long tongue of hemlock is flanked by Shasta firs

from the zone below, so that the usual zone relations are changed, parallel strips of Canadian and Hudsonian running up and down the mountain—instead of encircling it in the usual horizontal belts. Along Squaw Creek another tongue of alpine hemlock descends to the head of the main fall, at an altitude of about 7,250 feet, and is similarly sandwiched between ascending tongues of Shasta firs.

Between 'The [South] Gate' and the grove of alpine hemlocks on upper Squaw Creek is a prominent mass of lava 700 or 800 feet high, known as 'Red Butte.' It is about 2,000 feet below the altitude of extreme timberline and its summit is covered with trees; nevertheless its precipitous northeast side is so cold that its zone position is well above timberline, as shown by the presence there of such distinctively alpine plants as *Oxyria digyna* and *Saxifraga tolmiei*. In this case the



FIG. 29.—Dwarf pines ending abruptly along cold east side of ridge.

effect of a very cold mass of rock is added to that of the coldest slope, and the result is a lowering of alpine zone species 2,000 feet below their normal elevation on the hottest southwest slopes.

The high north and south ridges afford perhaps the simplest example of the direct influence of slope exposure. The warm west sides of these ridges usually bear trees in proportion to the availability of their slopes, while the cold east sides remain naked and alpine (see fig. 14). The way the dwarf pines stop along the east crest of the ridges is shown in the accompanying figure (fig. 29).

Finally, the glaciers of Shasta afford impressive evidence of the effects of slope exposure. My party did not take the altitudes of the glaciers, but according to the Shasta map sheet of the U. S. Geological Survey those on the cold east and northeast slopes descend below 9,000 feet, and one of them, at the head of Ash Creek, below 8,500 feet, while the only one having a south exposure (at the head of Mud Creek) stops at 11,000 feet,¹ and there are no glaciers at all on the west

¹There is another glacier on the south side, tributary to Mud Creek, which descends lower than the one marked on the map as 'Konwakiton glacier,' but it is completely hidden by a high ridge and is not exposed to the late afternoon sun.

side. Hence if the altitudes to which glaciers descend on the various slopes be accepted as indicating the course of a sinuous line of equal temperature, it follows that the difference in temperature dependent on the angle and conditions of slope exposure, as measured by the glaciers, is equivalent to a difference of upward of 2,000 feet in altitude. But this is doubtless excessive and due in part to local influences.

EFFECTS OF STEEP SLOPES.

Steep slopes, particularly those that face the southwest and west, exaggerate the effects of slope exposure. Those that face the hot afternoon sun at nearly a right angle receive the greatest quantity of heat, but this alone is not sufficient to account for the very extraordinary degree to which the fauna and flora are sometimes affected. When it is remembered that the hottest ordinary slopes carry up the zones only 800 to 1,000 feet, one is startled to find that on some favorable steep slopes they are pushed up more than 2,000 feet above their normal limits. The explanation did not occur to me until, in discussing the matter with the geologist, G. K. Gilbert, he suggested the diurnal ascending current as the missing factor.

It is well known that in ordinary calm weather the air currents on mountain sides and in deep canyons ascend by day and descend by night. The ascending currents are warm, the descending currents cold. The night current, being in the main free from local influences that affect its temperature, must exert an essentially equal effect on all sides of a mountain; but the temperature of the ascending day current, being constantly exposed to and in fact created by the influence of the sun, must vary enormously on different slopes. The activity and effectiveness of this current increases with the steepness of the slope and the directness of its exposure to the afternoon sun. Hence the hottest normal slopes—those that face the sun at nearly a right angle during the hottest part of the day—are rendered still more potent by increased steepness, the direct exposure to the sun keeping up the supply of heat while the steepness of the slope accelerates the rate of movement of the diurnal ascending current, carrying the heated air upward a very great distance before it has time to be cooled by the general temperature of the stratum it penetrates. Thus it is that species characteristic of the Transition zone on Shasta—species which on normal southwesterly slopes attain their upper limits at an altitude of 5,500 to 5,700 feet—are in favorable places enabled to live at elevations of 7,900 and even 8,000 feet, considerably more than 2,000 feet above their normal upper limits.

The steep slopes of Diller Canyon furnish instructive illustrations of the effects of these ascending hot-air currents. Here, on the hot stony pumice slopes, such distinctive Transition zone species as *Arctostaphylos patula*, *Kunzia tridentata*, *Ceanothus velutinus*, and *Chrysothamnus occidentalis* flourish among the Shasta firs and white-bark pines at an altitude of nearly 8,000 feet in the belt where the Canadian and Hudsonian zones overlap, and more than 2,000 feet above the extreme upper limit of their normal distribution on uncomplicated hot southwesterly slopes.

BASIN SLOPES.

Many of the glacial basins of the timberline region are broad U-shaped depressions with gently sloping bottoms, ending abruptly in terminal moraines, below which they may or may not continue on to other moraines. They were excavated by glaciers at a period when the ice cap of Shasta was much larger and more complete than at present. The upper ends of most of these valleys abut against the steep upper slopes of the peak, and are bordered on both sides by lofty ridges, so that they are walled in on three sides and thus converted into basins. Such basins, when they face the southwest, appear to promote the reflection of heat and retard the escape of hot air, so that they sometimes become hot pockets characterized by species belonging to the zone below.

LIFE ZONES OF SHASTA.

Shasta stands on a Transition zone plane, with a dilute tongue of Upper Sonoran approaching its northern base by way of Klamath and Shasta valleys. Its forested slopes rise quickly through the Boreal zones to timberline, above which its ice-clad summit towers to a height of 5,000 feet. The life zones of Shasta, therefore, beginning with the Upper Sonoran element of Shasta Valley, are—

Upper Sonoran
Transition
Canadian

Hudsonian
Arctic-Alpine.

In a generalized diagrammatic north and south section of the mountain the relations of these zones may be shown somewhat as follows:

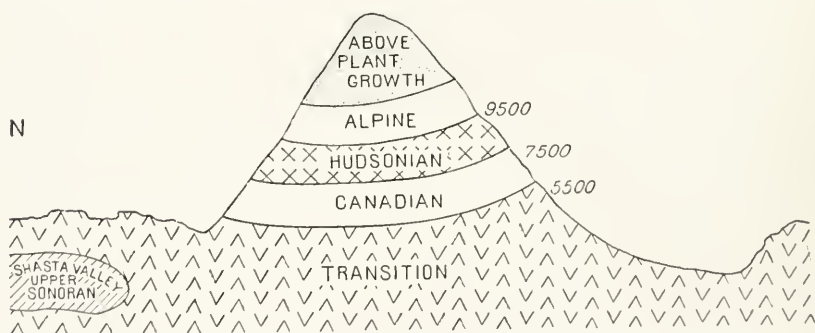


FIG. 30.—Diagram of Shasta showing relations of life zones.

The altitudes of zone boundaries here given are intended to represent their average or mean elevation on normal southerly slopes. The aridity of the mountain as a whole, with consequent scattered or 'spotty' instead of 'continuous' distribution of most of its zone species, complicated by the influences of hot and cold slopes, springs, and air currents, elsewhere discussed, which frequently carry species 1,000 feet or more above or below their normal limits, makes it almost impossible

to fix with certainty the normal zone altitudes. Hence those here given must be regarded as approximate only. The average width of the belt of overlapping of adjoining zones appears to be about 800 feet; so that the normal vertical distribution of the distinctive species of each zone overreaches in both directions the altitudes given by about 400 feet.

The zone positions accorded the various species are based on personal field experience, and in the great majority of cases are believed to be correct; in a few instances, however, the evidence is inconclusive—hence the zone lists must be regarded as provisional and subject to correction. Species recently exterminated or driven away, as the mountain sheep, elk, and grizzly bear, are included in the tables.

UPPER SONORAN ZONE.

The Upper Sonoran element in the region about Shasta is dilute and is limited to Shasta Valley at the north base of the mountain, which it reaches by way of the Klamath country on the north and northeast. It has no connection whatever with the Upper Sonoran of the Sacramento Valley on the south, which ends near the point where Pitt River joins the Sacramento, about 50 miles below Shasta.

Shasta Valley is an arid plain about 25 miles in length by 10 or 12 in breadth, studded with small volcanic buttes and lava flows. It varies in altitude from a little less than 4,000 to about 2,700 feet, and is lowest at the north, where the Shasta River, by which it is traversed, flows into the Klamath River. Shasta River is in places bordered by deciduous trees, mainly *Populus trichocarpa*, *Betula occidentalis*, and *Alnus rhombifolia*. The valley is sparsely covered with rabbit brush of several species, mainly *Chrysothamnus occidentalis* and *C. viscidiflorus*, and in some places, chiefly on the east and south, by the true sagebrush (*Artemisia tridentata*). The southeastern part contains an open forest of junipers (*Juniperus occidentalis*), which meets the pine forest of the basal slopes of the mountain. The western part is an open plain very scantily dotted with rabbit brush and a few small and mainly inconspicuous plants, among which were observed: *Mentzelia laevicaulis*, *Xanthium strumarium*, *Heliotropium curassavicum*, *Verbena bracteosa*, *Datura meteloides*, *Sarcobatus vermiculatus* and *Nicotiana* sp.? Along the western border of the valley, near the Scott Mountains, several characteristic shrubs occur, among which are *Ceanothus cuneatus*, *Arctostaphylos (viscida?)*, *Cercocarpus parvifolius*, *Eriodictyon glutinosum*, and *Garrya fremonti*.¹

The zone position of this region is further indicated by the presence of such birds as the chat (*Icteria virens longicauda*), bush-tit (*Psaltriparus minimus californicus*), California towhee (*Pipilo fuscus crissalis*), California jay (*Aphelocoma californica*), and California valley quail (*Lophortyx californicus callicola*). Formerly antelope were common here, but now they are rarely seen. The most abundant mammals are jack rabbits (*Lepus californicus*), sagebrush cottontails (*Lepus nut*

¹ *Garrya fremonti* is both Upper Sonoran and Transition.

talli), kangaroo rats (*Dipodomys californicus*), pocket mice (*Perognathus parvus*?), woodrats (*Neotoma fuscipes*), coyotes (*Canis ochropus*), and raccoons (*Procyon psora pacifica*).

So little work was done in Shasta Valley that the species mentioned are of course only a fraction of those present.

MAMMALS OF UPPER SONORAN ZONE (IN SHASTA VALLEY).

Restricted to Upper Sonoran.

| | |
|--------------------------------|---------------------------------------|
| <i>Lepus californicus</i> . | <i>Perognathus</i> (parvus?). |
| <i>Lepus nuttalli</i> . | <i>Peromyscus truei</i> . |
| <i>Microtus californicus</i> . | <i>Reithrodontomys klamathensis</i> . |

Common to Upper Sonoran and Transition.

| | |
|---------------------------------|---------------------------------|
| <i>Antilocapra americana</i> . | <i>Procyon psora pacifica</i> . |
| <i>Canis ochropus</i> . | <i>Scapanus californicus</i> . |
| <i>Dipodomys californicus</i> . | <i>Spermophilus douglasi</i> . |
| <i>Mephitis occidentalis</i> . | <i>Spilogale latifrons</i> . |
| <i>Myotis evotis</i> . | <i>Taxidea taxus</i> . |
| <i>Neotoma fuscipes</i> . | <i>Vespertilio fuscus</i> . |
| <i>Peromyscus gambeli</i> . | ? <i>Zapus pacificus</i> . |

BIRDS OF UPPER SONORAN ZONE (IN SHASTA VALLEY).

Restricted to Upper Sonoran.

| | |
|---|---|
| <i>Catherpes mexicanus punctulatus</i> . | <i>Lanius ludovicianus excubitorides</i> . |
| <i>Chondestes grammacus strigatus</i> . | <i>Otocoris alpestris merrilli</i> . |
| <i>Cyanocephalus cyanocephalus</i> . ¹ | <i>Pipilo fuscus crissalis</i> . |
| <i>Falco mexicanus</i> . | <i>Psaltiriparus minimus californicus</i> . |

Common to Upper Sonoran and Transition.

| | |
|---|---|
| <i>Aphelocoma californica</i> . | <i>Melanerpes formicivorus bairdi</i> . |
| <i>Astragalinus psaltria</i> . | <i>Phalaenoptilus nuttalli</i> . |
| <i>Buteo swainsoni</i> . | <i>Pipilo maculatus megalonyx</i> . |
| <i>Calypte anna</i> . | <i>Scolecophagus cyanocephalus</i> . |
| <i>Carpodacus mexicanus obscurus</i> . | <i>Speotyto cunicularia hypogaea</i> . |
| <i>Cathartes aura</i> . | <i>Spizella socialis arizonae</i> . |
| <i>Chondestes grammacus strigatus</i> . | <i>Sturnella magna neglecta</i> . |
| <i>Chordeiles virginianus</i> . | <i>Thryomanes bewicki spilurus</i> . |
| <i>Cyanospiza amena</i> . | <i>Troglodytes aëdon parkmani</i> . |
| <i>Dendroica aestiva</i> . | <i>Tyrannus verticalis</i> . |
| <i>Geothlypis trichas occidentalis</i> . | <i>Vireo gilvus swainsoni</i> . |
| <i>Icteria virens longicauda</i> . | <i>Zenaidura macroura</i> . |
| <i>Lophortyx californicus vallicola</i> . | |

TRANSITION ZONE.

Excepting Shasta Valley, the Transition zone covers the whole country about Shasta and pushes up over the basal slopes to an altitude of 5,000 or 6,000 feet. To the northeast and east it reaches and extends beyond the Klamath country and Goose Lake in Oregon, and the Madeline Plains in extreme northeastern California, interrupted only by narrow tongues of Upper Sonoran in the upper Pitt River Valley, and by small islands of Canadian on the highest mountain summits.

¹The piñon jay visits the juniper forests in Shasta Valley in fall to feed on the juniper berries, but whether or not it breeds there is not known.

To the south the Transition zone fills the McCloud and Pitt River valleys, embraces the canyon of the Sacramento, and stretches onward along the flanks of the Sierra all the way to southern California. To the west it overspreads the wild mountain region between Shasta and the Pacific Ocean, changing gradually from Arid Transition to Humid Transition, and surrounding the Upper Sonoran bottoms of Scott and Hoopa valleys, and the Boreal summits of Salmon, Trinity, and Siskiyou mountains. It covers the lower slopes and eastern part of the Siskiyou, and passes around the southern ends of the Salmon and Trinity mountains continuously to the sea.

On the flanks of Shasta the Transition zone forms a broad continuous belt covering the basal slopes on the northwest, west, and south, but interrupted on the cold east and northeast sides by the Boreal, which here pushes down to the actual base of the mountain, crowding the Transition out to the east around a group of low volcanic hills.

On the southwest and west it pushes up on ordinary slopes to 5,500 or 6,000 feet, rising on steep pumice canyon slopes a couple of thousand feet higher, and everywhere embracing tongues of Canadian which descend along the cold streams and on the cold easterly slopes of ridges.

On Shasta the study of the Transition zone is complicated by strong local differences of soil-moisture and humidity—differences that exert a profound effect on the distribution of plants, and to a less degree on that of animals also. It has been shown elsewhere (Life Zones and Crop Zones of the United States, p. 28, September, 1898) that in some places the Arid Transition of the Rocky Mountains and Great Basin passes gradually into the Humid Transition of the Pacific coast. On Shasta similar changes occur in such small compass that they may be studied to excellent advantage. Thus, near the south end of Shasta Valley the dominant types of vegetation are *Pinus ponderosa*, *Quercus californica*, *Artemisia tridentata*, *Kunzia tridentata*, *Arctostaphylos patula*, *Chrysothamnus occidentalis*, *Rhus trilobata*, *Garrya fremonti*, and *Prunus subcordata*, all characteristic Arid Transition species. On moister soils near by, particularly in shady canyons, the dominant types are *Pseudotsuga mucronata*, *Abies concolor lowiana*, *Acer glabrum*, *Cornus nuttallii*, *Rubus parviflorus* (= *nutkanus* Auct.) *Spiraea douglasii* and other Humid Transition species.

In this connection it is important to bear in mind that the extreme bottom of the west slope of Shasta, between the Sacramento River and Shasta Valley (elevation about 3,400 feet), is decidedly cooler and more boreal than the middle part of the slope 1,000 or 2,000 feet higher. The reason is twofold: The bottom part of the west slope, from the head of the Sacramento Canyon northward, lies close to the east base of Mount Eddy and the Scott Mountains, by which it is shielded from the late afternoon sun, and consequently receives less heat than higher parts of the same slope. Furthermore, it is well watered, and the rapid evaporation caused by the dry atmosphere tends to lower the tem-

perature still more. Higher parts of the same slope are not only very much drier, but are exposed to the direct rays of the afternoon sun, which, owing to the increasing steepness, strike the ground more nearly at a right angle than at lower elevations, the result being a material increase in the amount of heat received. It is obvious, therefore, that on the southwest and west slopes the middle part of the Transition zone is the hottest and driest, the part in which low Transition or even Upper Sonoran species are most apt to be found, while the *upper* and *lower* parts are coolest and dampest, the parts most likely to be invaded by Canadian zone species. Hence it is not surprising that Douglas and white firs, willows, alders, elder, snowberry, red spiraea, osier, and thimbleberry flourish at the top and bottom of the Transition slope, but are absent from the middle part. At the extreme foot of the slope, along the cool streams near Sisson Tavern, two normally boreal plants occur which were not found at all in the boreal belts on the mountain. These are *Linnaea borealis* and *Pachystima myrsinites*. With them is associated the mountain chinquapin (*Castanopsis sempervirens*). There is something peculiar about the distribution of *Pachystima*. It is abundant in the neighborhood of Sisson Tavern and occurs here and there, apparently on dry soil, up to an altitude of 4,700 feet, but not above. Since all three of these species are boreal, it is possible that the forms here referred to are Transition zone subspecies.

MAMMALS OF TRANSITION ZONE.

(1) *Species known to occur in the Transition zone of Shasta.*

| | |
|---|---|
| <i>Antilocapra americana</i> . | <i>Odocoileus columbianus</i> . |
| <i>Bassariscus astutus</i> raptor. | <i>Perognathus mollipilosus</i> . |
| <i>Callospermophilus chrysodeirus</i> . | <i>Peromyscus boylii</i> . |
| <i>Canis ochropus</i> . | <i>Peromyscus gambeli</i> . |
| <i>Castor canadensis</i> . ¹ | <i>Procyon psora pacifica</i> . |
| <i>Cervus occidentalis</i> . | <i>Scapanus californicus</i> . |
| <i>Dipodomys californicus</i> . | <i>Sciuropterus</i> (klamathensis?). |
| <i>Erethizon epixanthus</i> . | <i>Sciurus albolimbatus</i> . |
| <i>Entomias amoenus</i> . | <i>Sciurus fessor</i> . |
| <i>Entomias senex</i> . | <i>Sorex montereyensis</i> . |
| <i>Felis oregonensis</i> . | <i>Sorex vagrans amoenus</i> . |
| <i>Lutra hudsonica</i> . | <i>Spermophilus douglasi</i> . |
| <i>Lutreola vison</i> . | <i>Spilogale latifrons</i> . |
| <i>Lynx fasciatus pallescens</i> . | <i>Taxidea taxus</i> . |
| <i>Mephitis occidentalis</i> . | <i>Thomomys monticola pinetorum</i> . |
| <i>Microtus montanus</i> . | <i>Urocyon californicus townsendi</i> . |
| <i>Microtus mordax</i> . ¹ | <i>Ursus americanus</i> . |
| <i>Myotis evotis</i> . | <i>Ursus horribilis</i> . |
| <i>Myotis lucifugus longicrus</i> . | <i>Vespertilio fuscus</i> . |
| <i>Neotoma cinerea</i> . | <i>Vulpes macroturus</i> . ² |
| <i>Neotoma fuscipes</i> . | <i>Zapus pacificus</i> . |
| <i>Nerotrichus gibbsi major</i> . | |

¹ Restricted to cold streams which though traversing the Transition zone afford Boreal temperatures.

² Probably does not breed below Canadian.

MAMMALS OF TRANSITION ZONE—continued.

(2) *Restricted to Transition zone.*

| | |
|------------------------------------|--|
| <i>Bassariscus astutus raptor.</i> | ? <i>Microtus montanus.</i> |
| <i>Lynx fasciatus pallescens.</i> | <i>Sciurus fossor.</i> |
| ? <i>Mephitis occidentalis.</i> | <i>Urocyon californicus townsendi.</i> |

(3) *Common to Transition and Upper Sonoran zones.*

[See p. 54.]

(4) *Common to Transition and Canadian zones.*

| | |
|--|---|
| <i>Callospermophilus chrysodeirus.</i> | <i>Perognathus mollipilosus.</i> |
| <i>Cervus occidentalis.</i> | <i>Peromyscus boyli.</i> |
| <i>Erethizon epixanthus.</i> | <i>Peromyscus gambeli.</i> |
| <i>Eutamias amoenus.</i> | <i>Scapanus californicus.</i> |
| <i>Eutamias senex.</i> | <i>Sciuropterus alpinus klamathensis?</i> |
| <i>Felis oregonensis.</i> | <i>Sciurus albolimbatus.</i> |
| <i>Lutra hudsonica.</i> | <i>Sorex montereyensis.</i> |
| <i>Lutreola vison energumenos.</i> | <i>Sorex vagrans amoenus.</i> |
| <i>Microtus mordax.</i> | <i>Taxidea taxus.</i> |
| <i>Myotis lucifugus longicus.</i> | <i>Ursus americanus.</i> |
| <i>Neotoma cinerea.</i> | <i>Ursus horribilis.</i> |
| <i>Neotrichus gibbsi major.</i> | <i>Vulpes macronurus.¹</i> |
| <i>Odocoileus columbianus.</i> | |

BIRDS OF TRANSITION ZONE.

(1) *Species known to occur in Transition zone of Shasta.*

| | |
|--|--|
| <i>Aphelocoma californica.</i> | <i>Empidonax difficilis.</i> |
| <i>Aquila chrysaetos.</i> | <i>Empidonax hammondi.</i> |
| <i>Astragalinus psaltria.</i> | <i>Empidonax wrighti.</i> |
| <i>Astragalinus tristis salicamans.</i> | <i>Falco sparverius.</i> |
| <i>Bubo virginianus.</i> | <i>Geothlypis tolmiei.</i> |
| <i>Buteo borealis calurus.</i> | <i>Geothlypis trichas occidentalis.</i> |
| <i>Buteo swainsoni.</i> | <i>Glaucoideus gnoma californicum.</i> |
| <i>Calypte anna.</i> | <i>Helminthophila celata lutescens.</i> |
| <i>Carpodacus mexicanus obscurus.</i> | <i>Helminthophila rubricapilla gutturalis.</i> |
| <i>Cathartes aura.</i> | <i>Hirundo erythrogastra.</i> |
| <i>Ceophloeus pileatus abieticola.</i> | <i>Hylocichla aonalaschkae auduboni.</i> |
| <i>Certhia familiaris occidentalis.</i> | <i>Icteria virens longicauda.</i> |
| <i>Chaetura vauxi.</i> | <i>Lophortyx californicus vallicola.</i> |
| <i>Chondestes grammacus strigatus.</i> | <i>Melanerpes formicivorus bairdi.</i> |
| <i>Chordeiles virginianus.</i> | <i>Melanerpes torquatus.</i> |
| <i>Circus hudsonius.</i> | <i>Melospiza lincolni.</i> |
| <i>Colaptes cafer.</i> | <i>Melospiza melodia montana.</i> |
| <i>Contopus borealis.</i> | <i>Merula migratoria propinqua.</i> |
| <i>Contopus richardsoni.</i> | <i>Oreortyx pictus plumiferus.</i> |
| <i>Cyanocitta stelleri.</i> | <i>Oreospiza chlorura.</i> |
| <i>Cyanospiza amena.</i> | <i>Passerella iliaca megarhyncha.</i> |
| <i>Dendragapus obscurus fuliginosus.</i> | <i>Petrochelidon lunifrons.</i> |
| <i>Dendroica aestiva.</i> | <i>Phalaenoptilus nuttalli.</i> |
| <i>Dendroica auduboni.</i> | <i>Pipilo maculatus megalonyx.</i> |
| <i>Dryobates pubescens gairdneri.</i> | <i>Piranga ludoviciana.</i> |
| <i>Dryobates villosus hyloscopus.</i> | <i>Scolecophagus cyanocephalus.</i> |

¹ Supposed to breed in Canadian and wander over Transition.

BIRDS OF TRANSITION ZONE--continued.

(1) *Species known to occur in Transition zone of Shasta*—Continued.

| | |
|---------------------------------------|-------------------------------------|
| <i>Selasphorus rufus.</i> | <i>Tachycineta thalassina.</i> |
| <i>Sialia mexicana occidentalis.</i> | <i>Thryomanes bewicki spilurus.</i> |
| <i>Sitta carolinensis aculeata.</i> | <i>Troglodytes aëdon parkmani.</i> |
| <i>Sitta pygmaea.</i> | <i>Tyrannus verticalis.</i> |
| <i>Speotyto cunicularia hypogaea.</i> | <i>Vireo gilvus swainsoni.</i> |
| <i>Sphyrapicus ruber.</i> | <i>Vireo solitarius cassini.</i> |
| <i>Spizella socialis arizonæ.</i> | <i>?Wilsonia pusilla pileolata.</i> |
| <i>Stellula calliope.</i> | <i>Xenopicus albolarvatus.</i> |
| <i>Sturnella magna neglecta.</i> | <i>Zamelodia melanocephala.</i> |
| <i>Tachycineta bicolor.</i> | <i>Zenaidura macroura.</i> |

(2) *Restricted to Transition zone.*

| | |
|---------------------------------------|---|
| <i>?Chaetura vanxi.</i> | <i>Passerella iliaca megarhyncha.</i> |
| <i>Contopus richardsoni.</i> | <i>Sialia mexicana occidentalis.</i> ¹ |
| <i>Dryobates pubescens gairdneri.</i> | <i>Sitta pygmaea.</i> |
| <i>Glaucidium gnoma californicum.</i> | <i>Sphyrapicus ruber.</i> |
| <i>Melanerpes torquatus.</i> | <i>Vireo solitarius cassini.</i> |
| <i>Oreospiza chlorura.</i> | <i>Zamelodia melanocephala.</i> ¹ |

(3) *Common to Transition and Upper Sonoran zones.*

[See p. 54.]

(4) *Common to Transition and Canadian zones.*

| | |
|--|--|
| <i>Aquila chrysaëtos.</i> | <i>Falco sparverius.</i> |
| <i>Bubo virginianus.</i> | <i>Geothlypis tolmiei.</i> |
| <i>Buteo borealis calurus.</i> | <i>Helminthophila celata lutescens.</i> |
| <i>Ceophloeus pileatus abieticola.</i> | <i>Helminthophila rubricapilla gutturalis.</i> |
| <i>Certhia familiaris occidentalis.</i> | <i>Hylocichla aonalaschkeæ auduboni.</i> |
| <i>Chordeiles virginianus.</i> | <i>Melospiza lincolni.</i> |
| <i>Colaptes cafer.</i> | <i>Merula migratoria propinqua.</i> |
| <i>Contopus borealis.</i> | <i>Oreortyx pictus plumiferus.</i> |
| <i>Cyanocitta stelleri.</i> | <i>Piranga ludoviciana.</i> |
| <i>Dendragapus obscurus fuliginosus.</i> | <i>Selasphorus rufus.</i> |
| <i>Dendroica auduboni.</i> | <i>Sitta carolinensis aculeata.</i> |
| <i>Dryobates villosus hyloscopus.</i> | <i>Stellula calliope.</i> |
| <i>Empidonax difficilis.</i> | <i>Wilsonia pusilla pileolata.</i> |
| <i>Empidonax hammondi.</i> | <i>Xenopicus albolarvatus.</i> |
| <i>Empidonax wrighti.</i> | |

PLANTS OF TRANSITION ZONE.

(1) *Species known to occur in the Transition zone of Shasta.*

| | |
|--------------------------------|-------------------------------|
| <i>Abies concolor lowiana.</i> | <i>Antennaria geyeri.</i> |
| <i>Acer circinatum.</i> | <i>Apocynum pumilum.</i> |
| <i>Acer glabrum.</i> | <i>Aquilegia truncata.</i> |
| <i>Acer macrophyllum.</i> | <i>Arctostaphylos patula.</i> |
| <i>Achillea lanulosa.</i> | <i>Artemisia ludoviciana.</i> |
| <i>Alnus tenuifolia.</i> | <i>Artemisia tridentata.</i> |
| <i>Amelanchier alnifolia.</i> | <i>Asarum hartwegi.</i> |
| <i>Anaphalis margaritacea.</i> | <i>Betula occidentalis.</i> |

¹ Probably common to Transition and Upper Sonoran.

PLANTS OF TRANSITION ZONE—continued.

(1) *Species known to occur in Transition zone of Shasta*—Continued.

| | |
|---|---|
| <i>Carum gairdneri</i> . | <i>Lotus americanus</i> . |
| <i>Castanopsis sempervirens</i> . | <i>Lupinus elmeri</i> . |
| <i>Ceanothus cordulatus</i> . | <i>Lupinus minimus</i> . |
| <i>Ceanothus integerrimus</i> . | <i>Machaeranthera shastensis</i> (large form) |
| <i>Ceanothus (Cerastes) prostratus</i> . | <i>Mimulus moniliformis</i> . |
| <i>Ceanothus velutinus</i> . | <i>Mimulus tilingi</i> . |
| <i>Cerasus demissa</i> . | <i>Osmorrhiza nuda</i> . |
| <i>Cerasus emarginata</i> . | <i>Pachystima myrsinites</i> . |
| <i>Cerasus glandulosa</i> . | <i>Paeonia browni</i> . |
| <i>Cercocarpus ledifolius</i> . | <i>Pentstemon confertus</i> (form not typical). |
| <i>Cercocarpus parvifolius</i> . | <i>Phacelia magellanica</i> . |
| <i>Chamaesaracha nana</i> . | <i>Pinus attenuata</i> . |
| <i>Chimaphila menziesi</i> . | <i>Pinus lambertiana</i> . |
| <i>Chimaphila umbellata</i> . | <i>Pinus ponderosa</i> . |
| <i>Chrysamphora californica</i> . | <i>Polygala cornuta</i> . |
| <i>Chrysothamnus bloomeri angustatus</i> . | <i>Populus trichocarpa</i> . |
| <i>Chrysothamnus occidentalis</i> . | <i>Potentilla glandulosa</i> (large form). |
| <i>Cornus nuttalli</i> . | <i>Prunus subcordata</i> . |
| <i>Cornus pubescens</i> . | <i>Pseudotsuga mucronata</i> . |
| <i>Corylus rostrata californica</i> . | <i>Ptiloria lactucina</i> . |
| <i>Crataegus rivularis</i> . | <i>Pyrola pecta</i> . |
| <i>Cryptanthus geminata</i> . | <i>Pyrola secunda</i> . |
| <i>Epilobium brevistylum</i> . | <i>Quercus californica</i> . |
| <i>Epilobium oregonense</i> . | <i>Rhamnus californica</i> (or <i>rubra</i>). |
| <i>Epilobium spicatum</i> . | <i>Rhus trilobata</i> . |
| <i>Eriogonum marifolium</i> . | <i>Ribes amictum</i> . |
| <i>Eriogonum nudum</i> . | <i>Ribes cereum</i> . |
| <i>Eupatorium occidentale</i> . | <i>Ribes klamathense</i> . |
| <i>Fragaria bracteata</i> . | <i>Ribes viscosissimum</i> . |
| <i>Fragaria chiloensis</i> . | <i>Rosa californica</i> . |
| <i>Fraxinus oregana</i> . | <i>Rosa gymnocarpa</i> . |
| <i>Fritillaria atropurpurea</i> . | <i>Rubus parviflorus</i> . |
| <i>Gayophytum ramosissimum</i> . | <i>Rubus vitifolius</i> . |
| <i>Gilia aggregata</i> . | <i>Salix lasiandra</i> . |
| <i>Gilia (Collomia) grandiflora</i> . | <i>Salix nuttalli</i> . |
| <i>Hastingsia alba</i> . | <i>Salix sitchensis</i> . |
| <i>Heleniasium rivulare</i> . | <i>Sambucus melanocarpa</i> . |
| <i>Hieracium lanatum</i> . | <i>Sisyrinchium bellum</i> . |
| <i>Hieracium albidiflorum</i> (large form). | <i>Smilax californica</i> . |
| <i>Hieracium cynoglossoides nudicaule</i> . | <i>Solidago elongata</i> . |
| <i>Hieracium greenii</i> . | <i>Sorbus sambucifolia</i> . |
| <i>Horkelia pseudocapitata</i> . | <i>Spiraea douglasii</i> . |
| <i>Juniperus occidentalis</i> . | <i>Stachys ingrata</i> . |
| <i>Kunzia tridentata</i> . | <i>Symphoricarpos pilosus</i> . |
| <i>Lappula nervosa</i> . | <i>Symphoricarpos racemosus</i> . |
| <i>Libocedrus decurrens</i> . | <i>Tritelia ixioides</i> . |
| <i>Lilium washingtonianum</i> . | <i>Vaccinium arbuscula</i> . |
| <i>Linnaea borealis</i> . | <i>Vagnera stellata</i> . |
| <i>Linum lewisii</i> . | |

PLANTS OF TRANSITION ZONE—continued.

(2) *Species restricted to Transition zone.*

| | |
|---|--|
| <i>Abies concolor lowiana.</i> | <i>Hieracium albidiflorum</i> (large form). |
| <i>Acer circinatum.</i> | <i>Hieracium cynoglossoides nudicaule.</i> |
| <i>Acer glabrum.</i> ^b | <i>Hieracium greenii.</i> |
| <i>Acer macrophyllum.</i> | <i>Horkelia pseudocapitata.</i> |
| <i>Achillea lanulosa.</i> | <i>Lappula nervosa.</i> |
| <i>Alnus tenuifolia.</i> | <i>Libocedrus decurrens.</i> |
| <i>Amelanchier alnifolia.*</i> | <i>Lilium washingtonianum.</i> |
| <i>Anaphalis margaritacea.</i> | <i>Linnaea borealis.*</i> ¹ |
| <i>Antennaria geyeri.</i> | <i>Linum lewisii.</i> |
| <i>Apocynum pumilum.</i> | <i>Lotus americanus.</i> |
| <i>Aquilegia truncata.</i> | <i>Lupinus minimus.</i> |
| <i>Arctostaphylos patula.</i> | <i>Osmorrhiza nuda.</i> |
| <i>Artemisia ludoviciana</i> (form). | <i>Pachystima myrsinites.*</i> |
| <i>Asarum hartwegii.</i> | <i>Paeonia brownii.</i> |
| <i>Ceanothus cordulatus.</i> | <i>Pinus attenuata.</i> |
| <i>Ceanothus integerrimus.</i> | <i>Pinus lambertiana.</i> |
| <i>Ceanothus</i> (<i>Cerastes</i>) <i>prostratus.</i> | <i>Pinus ponderosa.</i> |
| <i>Ceanothus velutinus.</i> | <i>Polygala cornuta.</i> |
| <i>Cerasus demissa.</i> | <i>Pseudotsuga mucronata.</i> |
| <i>Cerasus emarginata.</i> | <i>Quercus californica.</i> |
| <i>Cerasus glandulosa.</i> | <i>Rhamnus californica</i> (or <i>rubra</i>). |
| <i>Cercocarpus ledifolius.</i> | <i>Ribes klamathense.</i> |
| <i>Chrysamphora californica.</i> | <i>Ribes viscosissimum.</i> |
| <i>Chrysothamnus bloomeri angustatus.</i> | <i>Rosa californica.</i> |
| <i>Cornus nuttallii.</i> | <i>Rosa gymnocarpa.</i> |
| <i>Cornus pubescens.*</i> | <i>Rubus parviflorus.*</i> |
| <i>Corylus rostrata californica.</i> | <i>Rubus vitifolius.</i> |
| <i>Crataegus rivularis.*</i> | <i>Salix lasiandra.</i> |
| <i>Cryptantha geminata.</i> | <i>Sambucus melanocarpa.</i> |
| <i>Fragaria bracteata.</i> | <i>Sisyrinchium bellum.</i> |
| <i>Fragaria chiloensis.</i> | <i>Smilax californica.</i> |
| <i>Fritillaria atropurpurea.</i> | <i>Solidago elongata.</i> |
| <i>Gayophytum ramosissimum.</i> | <i>Symphoricarpos pilosus.</i> |
| <i>Gilia</i> (<i>Collomia</i>) <i>grandiflora.</i> | <i>Symphoricarpos racemosus.</i> |
| <i>Hastingsia alba.</i> | |

In other mountains the species marked with an asterisk (*) are believed to occur in the Canadian zone as well as the Transition.

(3) *Species common to Transition and Upper Sonoran zones.*

| | |
|------------------------------------|--------------------------------|
| <i>Alnus rhombifolia.</i> | <i>Fraxinus oregana.</i> |
| <i>Artemisia tridentata.</i> | <i>Juniperus occidentalis.</i> |
| <i>Betula occidentalis.</i> | <i>Kunzia tridentata.</i> |
| <i>Cercocarpus parvifolius.</i> | ? <i>Populus trichocarpa.</i> |
| <i>Chrysothamnus occidentalis.</i> | <i>Prunus subcordata.</i> |
| <i>Eriogonum nudum.</i> | <i>Rhus trilobata.</i> |

¹ *Linnaea borealis* is ordinarily a Boreal plant, but it was not found in the Boreal belt of Shasta, though common in places at Sisson. The Sisson form has been separated as var. *longiflora*, and may be worthy of recognition as a Transition zone subspecies.

PLANTS OF TRANSITION ZONE—continued.

(4) *Species common to Transition and Canadian zones.*

(Or growing on boundary between.)

| | |
|--|---|
| <i>Carum gairdneri.</i> | <i>Mimulus tilingi.</i> |
| <i>Castanopsis sempervirens.</i> | <i>Pentstemon confertus</i> (form not typical). |
| <i>Castilleja miniata.</i> | <i>Phacelia magellanica.</i> |
| <i>Chamaesaracha nana.</i> | <i>Potentilla glandulosa</i> (large form). |
| <i>Chimaphila menziesi.</i> | <i>Ptiloria lactucina.</i> |
| <i>Chimaphila umbellata.</i> | <i>Pyrola picta.</i> |
| <i>Epilobium brevistylum.</i> | <i>Pyrola secunda.</i> |
| <i>Epilobium oregonense.</i> | <i>Ribes amictum.</i> |
| <i>Epilobium spicatum.</i> | <i>Ribes cereum.</i> |
| <i>Eriogonum marifolium.</i> | <i>Salix nuttalli.</i> |
| <i>Eupatorium occidentale.</i> | <i>Salix sitchensis.</i> |
| <i>Gilia aggregata.</i> | <i>Sorbus sambucifolia.</i> |
| <i>Heleniastrum rivulare.</i> | <i>Spiraea douglasii.</i> |
| <i>Heracleum lanatum.</i> | <i>Stachys ingrata.</i> |
| <i>Lupinus elmeri.</i> | <i>Tritelia ixioides.</i> |
| <i>Machaeranthera shastensis</i> (large form). | <i>Vaccinium arbuscula.</i> |
| <i>Mimulus moniliformis.</i> | <i>Vagnera stellata.</i> |

CANADIAN ZONE.

The Canadian zone on Shasta forms a broad forest belt, usually several miles in width and about 2,000 feet in vertical depth, which completely encircles the mountain. On southwesterly slopes it begins at an altitude of about 5,000 to 5,500 feet and pushes up to 7,500 to 7,800 feet.

Excepting an area of lodge-pole pines (*Pinus murrayana*) on the northeast base of the mountain, the Canadian zone is everywhere marked by a continuous forest of stately trees, consisting of Shasta firs (*Abies shastensis*), mixed in places with silver pines (*Pinus monticola*). It is a dark, somber forest, growing on a blackish soil, with very little noticeable vegetation except scattered patches of dwarf manzanita in the dry woods, and lines of more succulent plants at widely distant intervals along the borders of streams.

MAMMALS OF CANADIAN ZONE.

(1) *Species known to occur in Canadian zone on Shasta.*

| | |
|--|-------------------------------------|
| <i>Apلودontia major.</i> | <i>Lutreola vison energumenos.</i> |
| <i>Callospermophilus chrysodeirus.</i> | <i>Microtus mordax.</i> |
| <i>Canis lestes.</i> | <i>Mustela caurina.</i> |
| <i>Cervus occidentalis.</i> | <i>Mustela pennanti.</i> |
| <i>Erethizon epixanthus.</i> | <i>Myotis lucifugus longierns.</i> |
| <i>Entomias amoenus.</i> | <i>Myotis yumanensis saturatus.</i> |
| <i>Entomias senex.</i> | <i>Neotoma cinerea.</i> |
| <i>Evotomys mazama.</i> | <i>Neurotrichus gibbsi major.</i> |
| <i>Felis oregonensis.</i> | <i>Odocoileus columbianus.</i> |
| <i>Lepus klamathensis.</i> | <i>Perognathus mollipilosus.</i> |
| <i>Lutra hudsonica.</i> | <i>Peromyscus boylii.</i> |

MAMMALS OF CANADIAN ZONE—continued.

(1) *Species known to occur in Canadian zone on Shasta*—Continued.

| | |
|--|----------------------------------|
| <i>Peromyscus gambeli</i> . | <i>Sorex vagrans amoenus</i> . |
| <i>Putorius arizonensis</i> . | <i>Taxidea taxus</i> . |
| <i>Scapanus californicus</i> . | <i>Thomomys monticola</i> . |
| <i>Sciuropterus alpinus klamathensis</i> ? | <i>Ursus americanus</i> . |
| <i>Sciurus albolimbatus</i> . | <i>Ursus horribilis</i> . |
| <i>Sorex montereyensis</i> . | <i>Vulpes macrourus</i> . |
| <i>Sorex (Neosorex) navigator</i> . | <i>Zapus trimotatus alleni</i> . |
| <i>Sorex shastensis</i> . | |

(2) *Species restricted to Canadian zone.*

| | |
|---------------------------------------|----------------------------------|
| <i>Aplodontia major</i> . | <i>Sorex shastensis</i> . |
| ? <i>Sorex (Neosorex) navigator</i> . | <i>Zapus trimotatus alleni</i> . |

(3) *Species common to Canadian and Transition zones.*

[See p. 57.]

(4) *Species common to Canadian and Hudsonian zones.*

| | |
|---|--------------------------------------|
| <i>Callospermophilus chrysodeirus</i> . | <i>Myotis yumanensis saturatus</i> . |
| <i>Canis leste</i> . | <i>Neotoma cinerea</i> . |
| <i>Erethizon epixanthus</i> . | <i>Odocoileus columbianus</i> . |
| <i>Entomias amoenus</i> . | <i>Perognathus molliplosus</i> . |
| <i>Entomias scax</i> . | <i>Peromyscus gambeli</i> . |
| <i>Evotomys mazama</i> . | <i>Putorius arizonensis</i> . |
| <i>Lepus klamathensis</i> . | <i>Sorex vagrans amoenus</i> . |
| <i>Microtus mordax</i> . | <i>Thomomys monticola</i> . |
| <i>Mustela caurina</i> . | <i>Vulpes macrourus</i> . |
| <i>Mustela pennanti</i> . | |

BIRDS OF CANADIAN ZONE.

(1) *Species known to occur in Canadian zone on Shasta.*

| | |
|--|---|
| <i>Accipiter atricapillus striatulus</i> . | <i>Heiminthophila celata lutescens</i> . |
| <i>Accipiter velox</i> . | <i>Heiminthophila rubricapilla gutturalis</i> . |
| <i>Aquila chrysaetos</i> . | <i>Hylocichla aonalaschke auduboni</i> . |
| <i>Bubo virginianus</i> . | <i>Junco hyemalis thurberi</i> . |
| <i>Buteo borealis calurus</i> . | <i>Loxia curvirostra bendirei</i> . |
| <i>Carpodacus cassinii</i> . | <i>Melospiza lincolni</i> . |
| <i>Ceophylus pileatus abieticola</i> . | <i>Merula migratoria propinqua</i> . |
| <i>Certhia familiaris occidentalis</i> . | <i>Myadestes townsendi</i> . |
| <i>Chordeiles virginianus</i> . | <i>Oreortyx pictus plumiferus</i> . |
| <i>Cinclus mexicanus</i> . | <i>Parus gambeli</i> . |
| <i>Coccothraustes vespertinus montanus</i> . | <i>Perisoreus obscurus</i> . |
| <i>Colaptes cafer</i> . | <i>Picoides arcticus</i> . |
| <i>Contopus borealis</i> . | <i>Piranga ludoviciana</i> . |
| <i>Cyanocitta stelleri</i> . | <i>Regulus calendula</i> . |
| <i>Dendragapus obscurus fuliginosus</i> . | <i>Regulus satrapa olivaceus</i> . |
| <i>Dendroica auduboni</i> . | <i>Selasphorus rufus</i> . |
| <i>Dendroica occidentalis</i> . | <i>Sitta canadensis</i> . |
| <i>Dryobates villosus hyloscopus</i> . | <i>Sitta carolinensis aculeata</i> . |
| <i>Empidonax difficilis</i> . | <i>Sphyrapicus thyroideus</i> . |
| <i>Empidonax hammondi</i> . | <i>Spinus pinus</i> . |
| <i>Empidonax wrighti</i> . | <i>Stellula calliope</i> . |
| <i>Falco sparverius</i> . | <i>Wilsonia pusilla pileolata</i> . |
| <i>Geothlypis tolmiei</i> . | <i>Xenopicus albolavatus</i> . |

BIRDS OF CANADIAN ZONE—continued.

(2) *Species restricted to Canadian zone.*

Loxia curvirostra bendirei.
Melospiza lincolni.

Picoides arcticus.

(3) *Species common to Canadian and Transition zones.*

[See p. 58.]

(4) *Species common to Canadian and Hudsonian zones.*

| | |
|---|--------------------------------------|
| <i>Accipiter atricapillus striatulus.</i> | ? <i>Loxia curvirostra bendirei.</i> |
| <i>Accipiter velox.</i> | <i>Myadestes townsendi.</i> |
| <i>Aquila chrysaetos.</i> | <i>Parus gambeli.</i> |
| <i>Carpodacus cassinii.</i> | <i>Perisoreus obscurus.</i> |
| <i>Cinclus mexicanus.</i> | <i>Regulus calendula.</i> |
| <i>Coccothraustes vespertinus montanus.</i> | <i>Regulus satrapa olivaceus.</i> |
| <i>Dendragapus obscurus fuliginosus.</i> | <i>Selasphorus rufus.</i> |
| <i>Dendroica auduboni.</i> | <i>Sitta canadensis.</i> |
| <i>Dendroica occidentalis.</i> | <i>Sphyrapicus thyroideus.</i> |
| <i>Falco sparverius.</i> | <i>Spinus pinus.</i> |
| <i>Junco hyemalis thurberi.</i> | <i>Stellula calliope.</i> |

PLANTS OF CANADIAN ZONE.

(1) *Species known to occur in Canadian zone on Shasta.*

| | |
|---|---|
| <i>Abies shastensis.</i> | <i>Heracleum lanatum.</i> |
| <i>Aconitum columbianum.</i> | <i>Holidiscus discolor</i> (large form). |
| <i>Allium validum.</i> | <i>Hypericum anagalloides.</i> |
| <i>Alnus sinuata.</i> | <i>Ligusticum grayi.</i> |
| <i>Arctostaphylos nevadensis.</i> | <i>Lilium parvum.</i> |
| <i>Arnica longifolia.</i> | <i>Lupinus elmeri.</i> |
| <i>Campanula wilkinsiana.</i> | <i>Madia bolanderi.</i> |
| <i>Carum gairdneri.</i> | <i>Machæranthera shastensis</i> (large form). |
| <i>Castanopsis sempervirens.</i> | <i>Mimulus monilliformis.</i> |
| <i>Castilleja miniata.</i> | <i>Mimulus primuloides.</i> |
| <i>Chamaesaracha nana.</i> | <i>Mimulus tiliugi.</i> |
| <i>Chimaphila menziesii.</i> | <i>Monardella odoratissima.</i> |
| <i>Chimaphila umbellata.</i> | <i>Pentstemon confertus</i> (form not typical). |
| <i>Chrysothamnus bloomeri.</i> | <i>Pentstemon densus.</i> |
| <i>Corallorhiza bigelovi.</i> | <i>Pentstemon gracilentus.</i> |
| ? <i>Crepis intermedia.</i> | <i>Phacelia magellanica.</i> |
| <i>Cymopterus terebinthinus</i> (large form). | <i>Phlox douglasii diffusa.</i> |
| <i>Delphinium sounei.</i> | <i>Pinus monticola.</i> |
| <i>Drosera rotundifolia.</i> | <i>Pinus murrayana.</i> |
| <i>Epilobium brevistylum.</i> | <i>Potentilla glandulosa</i> (large form). |
| <i>Epilobium oregonense.</i> | <i>Ptiloria lactucina.</i> |
| <i>Epilobium spicatum.</i> | <i>Pyrola pallida.</i> |
| <i>Erigeron inornatus.</i> | <i>Pyrola picta.</i> |
| <i>Eriogonum marifolium.</i> | <i>Pyrola secunda.</i> |
| <i>Enpatorium occidentale.</i> | <i>Ribes amictum.</i> |
| <i>Gentiana simplex.</i> | <i>Ribes cereum.</i> |
| <i>Gilia aggregata.</i> | <i>Salix nuttalli.</i> |
| <i>Habenaria leucostachys.</i> | <i>Salix sitchensis.</i> |
| <i>Habenaria unalaschensis.</i> | <i>Senecio trigonophyllus.</i> |
| <i>Heleniastrum rivulare.</i> | <i>Sorbus sambucifolia.</i> |

PLANTS OF CANADIAN ZONE—continued.

(1) *Species known to occur in Canadian zone on Shasta—Continued.*

| | |
|--------------------------------|-------------------------------|
| <i>Spiraea douglasii.</i> | <i>Tritelia ixioides.</i> |
| <i>Spraguea umbellata.</i> | <i>Vaccinium occidentale.</i> |
| <i>Stachys ingrata.</i> | <i>Vagnera stellata.</i> |
| <i>Stellaria crispa.</i> | <i>Veratrum californicum.</i> |
| <i>Tofieldia occidentalis.</i> | <i>Viola blanda.</i> |

(2) *Species restricted to Canadian zone.*

| | |
|---------------------------------|--------------------------------|
| <i>Abies shastensis.</i> | <i>Lilium parvum.</i> |
| <i>Aconitum columbianum.</i> | <i>Madia bolanderi.</i> |
| <i>Allium validum.</i> | <i>Pentstemon densus.</i> |
| <i>Alnus sinuata.</i> | <i>Pentstemon gracilentus.</i> |
| <i>Arnica longifolia.</i> | <i>Pinus monticola.</i> |
| <i>?Corallorhiza bigelovi.</i> | <i>Pinus murrayana.</i> |
| <i>Delphinium sonnei.</i> | <i>Pyrola pallida.</i> |
| <i>Drosera rotundifolia.</i> | <i>Senecio trigonophyllus.</i> |
| <i>Erigeron inornatus.</i> | <i>Tofieldia occidentalis.</i> |
| <i>Gentiana simplex.</i> | <i>Vaccinium occidentale.</i> |
| <i>Habenaria leucostachys.</i> | <i>Viola blanda.</i> |
| <i>Habenaria unalaschensis.</i> | |

(3) *Species common to Canadian and Transition zones.*

[See p. 61.]

(4) *Species common to Canadian and Hudsonian zones.*

| | |
|-----------------------------------|---------------------------------|
| <i>Arctostaphylos nevadensis.</i> | <i>Ligusticum grayi.</i> |
| <i>Campanula wilkinsiana.</i> | <i>Mimulus primuloides.</i> |
| <i>Castanopsis sempervirens.</i> | <i>Monardella odoratissima.</i> |
| <i>Castilleja miniata.</i> | <i>Phlox douglasii diffusa.</i> |
| <i>Chrysothamnus bloomeri.</i> | <i>Ribes cereum.</i> |
| <i>Holodiscus discolor.</i> | <i>Spraguea umbellata.</i> |
| <i>Hypericum anagalloides.</i> | <i>Stellaria crispa.</i> |

HUDSONIAN ZONE.

The Hudsonian zone is the highest of the timber belts. Its sinuous upper border rises on the high ridges to inclose the narrow tongues of dwarf prostrate trees that push up on the warmest southwesterly exposures to an extreme altitude of 9,800 feet, but between the ridges it dips down a thousand feet or more, and is difficult to fix with precision. The lower border slightly overlaps the upper limit of Shasta firs. Two species of trees, and only two, grow in this zone—the black alpine hemlock (*Tsuga mertensiana*) and the white-bark pine (*Pinus albicaulis*). The hemlock is restricted to local spots, while the white-bark pine forms a practically continuous belt, as already explained (see p. 42). On warm southwesterly slopes the Hudsonian reaches from 7,500 or 7,800 up to 9,500, or in extreme cases to 9,800 feet.

MAMMALS OF HUDSONIAN ZONE.

(1) *Species known to occur in Hudsonian zone of Shasta.*

| | |
|--|---|
| <i>Callospermophilus chrysodeirus.</i> | <i>Ochotona schisticeps.</i> |
| <i>Canis lestes.</i> | <i>Odocoileus columbianus.</i> |
| <i>Erethizon epixanthus.</i> | <i>Ovis canadensis.</i> |
| <i>Eutamias amoenus.</i> | <i>Perognathus mollipilosus.</i> |
| <i>Eutamias senex.</i> | <i>Peromyscus gambeli.</i> |
| <i>Evotomys mazama.</i> | <i>Phenacomys orophilus.</i> |
| <i>Lepus klamathensis.</i> | <i>Putorius arizonensis.</i> |
| <i>Microtus mordax.</i> | ? <i>Sorex vagrans amoenus.</i> ¹ |
| <i>Mustela caurina.</i> | ? <i>Sorex (Neosorex) navigator.</i> ¹ |
| <i>Mustela pennanti.</i> | <i>Thomomys monticola.</i> |
| <i>Myotis yumanensis saturatus.</i> | <i>Vulpes macrourus.</i> |
| <i>Neotoma cinerea.</i> | ? <i>Zapus trinotatus alleni.</i> ¹ |

(2) *Species restricted to Hudsonian zone.**Ochotona schisticeps.*(3) *Species common to Hudsonian and Canadian zones.*

[See p. 62.]

(4) *Species common to Hudsonian and Alpine zones.*

| | |
|-----------------------------------|---------------------------------------|
| <i>Canis lestes.</i> ² | <i>Phenacomys orophilus.</i> |
| <i>Microtus mordax.</i> | <i>Thomomys monticola.</i> |
| <i>Ovis canadensis.</i> | <i>Vulpes macrourus.</i> ² |
| <i>Peromyscus gambeli.</i> | |

BIRDS OF HUDSONIAN ZONE.

(1) *Species known to occur in Hudsonian zone on Shasta.*

(Species queried are not positively known to breed in the Hudsonian, though frequently seen in this belt in July and August.)

| | |
|---|---------------------------------------|
| <i>Accipiter atricapillus striatulus.</i> | <i>Nucifraga columbiana.</i> |
| <i>Accipiter velox.</i> | <i>Parus gambeli.</i> |
| <i>Aquila chrysaetos.</i> | <i>Perisoreus obscurus.</i> |
| <i>Carpodacus cassinii.</i> | <i>Regulus calendula.</i> |
| ? <i>Certhia familiaris occidentalis.</i> | <i>Regulus satrapa olivaceus.</i> |
| <i>Cinclus mexicanus.</i> | <i>Salpinctes obsoletus.</i> |
| ? <i>Coccothraustes vespertinus montanus.</i> | <i>Selasphorus rufus.</i> |
| <i>Dendragapus obscurus fuliginosus.</i> | <i>Sialia arctica.</i> |
| ? <i>Dendroica auduboni.</i> | <i>Sitta canadensis.</i> |
| <i>Dendroica occidentalis.</i> | ? <i>Sitta carolinensis aculeata.</i> |
| <i>Falco sparverius.</i> | <i>Sphyrapicus thyroideus.</i> |
| <i>Junco hyemalis thurberi.</i> | <i>Spinus pinus.</i> |
| ? <i>Loxia curvirostra bendirei.</i> | <i>Stellula calliope.</i> |
| <i>Myadestes townsendi.</i> | <i>Zonotrichia leucophrys.</i> |

(2) *Species restricted to Hudsonian zone.*

| | |
|------------------------------|--------------------------------|
| <i>Nucifraga columbiana.</i> | <i>Zonotrichia leucophrys.</i> |
|------------------------------|--------------------------------|

¹ These three species occur along the lower edge of the Hudsonian zone, but were not obtained in its upper part, and it is not certain whether or not they should be included.

² Does not breed above Hudsonian.

BIRDS OF HUDSONIAN ZONE—continued.

(3) *Species common to Hudsonian and Canadian zones.*

[See p. 63.]

(4) *Species common to Hudsonian and Alpine zones.*Salpinctes obsoletus.¹

Sialia arctica.

Stellula calliope.

PLANTS OF HUDSONIAN ZONE.

(1) *Species known to occur in Hudsonian zone on Shasta.*

Agoseris monticola.

Allium sp. — ?

Antennaria media.

Arabis platysperma.

Arctostaphylos nevadensis.

Arnica merriami.

Arnica viscosa.

Campanula wilkinsiana.

Carex breweri.

Castanopsis sempervirens.

Castilleja affinis.

Castilleja miniata (small form).

Cheiranthus perennis.

Chrysanthemum bloomeri.

Crepis intermedia.

Cycladenia humilis.

Cymopterus terebinthinus.

Epilobium clavatum.

Epilobium obovatum.

Epilobium pringleanum.

Erigeron armeriaefolium.

Eriogonum polypodium.

Eriogonum pyrolaefolium.

Hieracium albiflorum (alpine form).

Hieracium gracile.

Hieracium horridum.

Holodiscus discolor.

Hypericum anagalloides.

Juncus parryi.

Juniperus nana.

Kalnia glauca microphylla.

Ligusticum grayi.

Lupinus albidifrons.

Lupinus cornatus.¹

Lutkea pectinata.

Machaeranthera shastensis.

Mimulus implexus.

Mimulus primuloides.

Mitella pentandra.

Monardella odoratissima.

Oreastrum alpinum.

Oreobroma triphylla.

Orthocarpus pilosus.

Parnassia californica.

Pentstemon glaber utahensis.

Pentstemon menziesii.

Pentstemon newberryi.

Phlox douglasii diffusa.

Phyllodoce empetrifolius.

Pinus albicanis.

Polygonum newberryi.

Polygonum shastense.

Potentilla flabellifolia.

Potentilla pseudornpestris.

Pulsatilla occidentalis.

Ribes cereum.

Saxifraga bryophora.

Scutellaria nana.

Sibbaldia procumbens.

Silene grayi.

Sitanion cinereum.

Spraguea umbellata.

Stellaria crispa.

Streptanthus orbiculatus.

Tsuga mertensiana.

Vaccinium caespitosum.

Veronica cusicki.

Viola purpurea.

(2) *Species restricted to Hudsonian zone.*

Allium sp. — ?

Arnica merriami.

Arnica viscosa.

?Castilleja affinis.

Castilleja miniata (small form).

Cycladenia humilis.

Epilobium clavatum.

Epilobium obovatum.

¹ On Shasta the rock wren is restricted closely to the Alpine and Hudsonian zones, but in other places it occurs much lower down, and was recently found in Shasta Valley by W. K. Fisher.

PLANTS OF HUDSONIAN ZONE—continued.

(2) *Species restricted to Hudsonian zone*—Continued.

| | |
|-------------------------------------|------------------------------|
| Epilobium pringleanum. | Pentstemon glaber utahensis. |
| Holodiscus discolor (typical form). | Pentstemon newberryi. |
| Juniperus nana. | Phyllodoce empetriflorus. |
| Kalmia glauca microphylla. | Pinus albicaulis. |
| Mimulus implexus. | Potentilla flabellifolia. |
| Mitella pentandra. | Potentilla pseudorupestris? |
| Oreobroma triphylla. | Scutellaria nana. |
| Orthocarpus pilosus. | Tsuga mertensiana. |
| Parnassia californica. | Vaccinium caespitosum. |

(3) *Species common to Hudsonian and Canadian zones.*

[See p. 64.]

(4) *Species common to Hudsonian and Alpine zones.*

| | |
|---------------------------------------|----------------------------|
| Agoseris monticola. | Lutkea pectinata. |
| Antennaria media. | Machaeranthera shastensis. |
| Arabis platysperma. | Oreastrum alpiginum. |
| Carex breweri. | Pentstemon menziesi. |
| Cheiranthus perennis. | Phlox douglasi diffusa. |
| Chrysothamnus bloomeri. | Polygonum newberryi. |
| Cymopterus terebinthinus. | Polygonum shastense. |
| Erigeron armeriaefolium. | Pulsatilla occidentalis. |
| Eriogonum polypodium. | Sibbaldia procumbens. |
| Eriogonum pyrolaefolium. | Silene grayi. |
| Hieracium albidiflorum (alpine form). | Sitanion cinereum. |
| Hieracium gracile. | Spraguea umbellata. |
| Hieracium horridum. | Streptanthus orbiculatus. |
| Junus parryi. | Veronica cusicki. |
| Ligusticum grayi. | Viola purpurea. |
| Lupinus 'ornatus.' | |

ALPINE ZONE.

The Alpine zone occupies the irregular belt of pumice and lava between timberline and the upper limit of plant growth. On the warmer southwesterly slopes its lower limit may be found at 9,500 to 9,800 feet, but on ordinary slopes it is considerably lower. The great majority of its species stop at or below an altitude of 11,000 feet, but on the relatively warm southwesterly slopes *Hulsea nana* was found at 11,300 feet, and two species, *Draba breweri* and *Polemonium pulchellum*, as high as 13,000 feet—the extreme limit of plant growth on Shasta.

MAMMALS OF ALPINE ZONE.

(1) *Species known to occur in Alpine zone on Shasta.*

| | |
|----------------------------|---------------------------------|
| Canis lestes. ¹ | Phenacomys orophilus. |
| Microtus mordax. | Thomomys monticola. |
| Ovis canadensis. | Vulpes macroturus. ¹ |
| Peromyscus gambeli. | |

(2) *Species restricted to Alpine zone.*

None.

¹ The coyote and fox range up into the Alpine zone, but do not breed above the Hudsonian and possibly not above the Canadian.

MAMMALS OF ALPINE ZONE—CONTINUED.

(3) *Species common to Alpine and Hudsonian zones.*

[See p. 65.]

BIRDS OF ALPINE ZONE.

(1) *Species known to occur in Alpine zone on Shasta.*

| | |
|---------------------------------|------------------------------|
| <i>Anthus pensilvanicus.</i> | <i>Salpinctes obsoletus.</i> |
| <i>Leucosticte tephrocotis.</i> | <i>Sialia arctica.</i> |
| <i>Nucifraga columbiana.</i> | <i>Stellula calliope.</i> |

(2) *Species restricted to Alpine zone.*

| | |
|------------------------------|---------------------------------|
| <i>Anthus pensilvanicus.</i> | <i>Leucosticte tephrocotis.</i> |
|------------------------------|---------------------------------|

(3) *Species common to Alpine and Hudsonian zones.*

[See p. 66.]

PLANTS OF ALPINE ZONE.

(1) *Species known to occur in Alpine zone on Shasta.*

| | |
|--|----------------------------------|
| <i>Achillea borealis.</i> | <i>Lupinus 'ornatus.'</i> |
| <i>Agoseris monticola.</i> | <i>Lutkea pectinata.</i> |
| <i>Antennaria media.</i> | <i>Machranthera shastensis.</i> |
| <i>Arabis platysperma.</i> | <i>Oreastrum alpinum.</i> |
| <i>Bikukulla uniflora.</i> | <i>Oxyria digyna.</i> |
| <i>Cardamine bellidifolia pachyphylla.</i> | <i>Pentstemon menziesi.</i> |
| <i>Carex breweri.</i> | <i>Phacelia frigida.</i> |
| <i>Chenactis nevadensis.</i> | <i>Phlox douglasii diffusa.</i> |
| <i>Cheiranthus perennis.</i> | <i>Polemonium pulchellum.</i> |
| <i>Chrysothamnus bloomeri.</i> | <i>Polygonum newberryi.</i> |
| <i>Cymopterus terebinthinus.</i> | <i>Polygonum shastense.</i> |
| <i>Draba breweri.</i> | <i>Pulsatilla occidentalis.</i> |
| <i>Erigeron armeriaefolium.</i> | <i>Sagina saginoides.</i> |
| <i>Erigeron compositus trifidus.</i> | <i>Saxifraga tolmiei.</i> |
| <i>Eriogonum polypodium.</i> | <i>Senecio canus.</i> |
| <i>Eriogonum pyrolaefolium.</i> | <i>Sibbaldia procumbens.</i> |
| <i>Hieracium albidiflorum (alpine form).</i> | <i>Silene grayi.</i> |
| <i>Hieracium gracile.</i> | <i>Silene suksdorfii.</i> |
| <i>Hieracium horridum.</i> | <i>Sitanion cinereum.</i> |
| <i>Hulsea larseni.</i> | <i>Spraguea umbellata.</i> |
| <i>Hulsea nana.</i> | <i>Streptanthus orbiculatus.</i> |
| <i>Juncus parryi.</i> | <i>Veronica cusicki.</i> |
| <i>Ligusticum grayi.</i> | <i>Viola purpurea.</i> |
| <i>Lupinus lyalli.</i> | |

(2) *Species restricted to Alpine zone.*

| | |
|--|-------------------------------|
| <i>Achillea borealis.</i> | <i>Lupinus lyalli.</i> |
| <i>Bikukulla uniflora.</i> | <i>Oxyria digyna.</i> |
| <i>Cardamine bellidifolia pachyphylla.</i> | <i>Phacelia frigida.</i> |
| <i>Chenactis nevadensis.</i> | <i>Polemonium pulchellum.</i> |
| <i>Draba breweri.</i> | <i>Sagina saginoides.</i> |
| <i>Erigeron compositus trifidus.</i> | <i>Saxifraga tolmiei.</i> |
| <i>Hulsea larseni.</i> | <i>Senecio canus.</i> |
| <i>Hulsea nana.</i> | <i>Silene suksdorfii.</i> |

(3) *Species common to Alpine and Hudsonian zones.*

[See p. 67.]

THE BOREAL FAUNA AND FLORA OF SHASTA CONTRASTED WITH CORRESPONDING FAUNAS AND FLORAS OF THE SIERRA AND THE CASCADES.

In considering the relations of the boreal faunas and floras of Shasta to those of other parts of the Sierra-Cascade system it is necessary at the outset to have a clear conception not only of the extent of the range as a whole, but also of the number and magnitude of the breaks or gaps in the continuity of its boreal fauna and flora. The Cascade Range enters the State of Washington from British Columbia in latitude 49° and pushes southward completely across Washington and Oregon; its continuation, the Sierra Nevada, traverses California for a distance of 500 miles, ending a little south of Mount Whitney, in about latitude 36°. The Cascade-Sierra system, therefore, extends over 13 degrees of latitude, and has a total length of fully 1,000 miles. For the whole of this distance it rises abruptly from a low region, whose faunas and floras are in the southern part Sonoran, in the northern part Transition. The field work of the Biological Survey has shown that the narrow boreal band which occupies the higher parts of the range is not continuous, but is interrupted by four important gaps, through which Transition zone species pass freely in broad belts from one side to the other. These gaps, beginning at the north, are:

(1) The *Columbia Gap*, or gorge of the Columbia River, on the boundary between Washington and Oregon, where the breadth of the Transition zone seems to be less than 50 miles.¹

(2) The *Klamath Gap*, on the boundary between Oregon and California, extending from a little south of Mount Pitt in Oregon to Mount Shasta in California, a distance of about 50 miles. This interval is interrupted by one or two detached groups of low mountains on the California side, and by long ridges on both sides, whose summits are inhabited by boreal species, materially decreasing the actual breadth of the gap.

(3) The *Pitt River Gap*, between Mounts Shasta and Lassen in northern California. The breadth of the Transition zone here is about 60 miles.

¹Although not bearing on the fauna of Shasta, it is interesting to note, in connection with the effects of the Columbia River Gap, that a number of species characteristic of the northern Cascades, in the State of Washington, do not occur in the southern Cascades, in Oregon. Among the mammals the most notable species of this kind are *Arctomys caligatus*, *Callospermophilus saturatus*, *Erotomys gapperi saturatus*, *Oreamnos montanus*, *Peromyscus oreas*, *Putorius washingtoni*, *Zapus trinotatus*.

(4) The *Feather River* or *Quincy Gap*, between Mount Lassen and the high ridge northwest of Honey Lake—the northern end of the Sierra proper. This gap is the shallowest, narrowest, most irregular, and least effective of all, and is the only one which has not been cut deeply and completely through the range by a large river. The Boreal zones of the two sides, at the points where they come nearest together, which is southeast of the southeastern extension of the boreal plateau on which Lassen stands, are not separated, apparently, by more than 15 miles. The distance between the Hudsonian elements appears to be several times greater. This region needs further exploration.

Fully half of the boreal species of Shasta are common to both the Sierra Nevada and the Cascade Range, and some of them extend over the entire length of the Sierra-Cascade system, inhabiting the principal boreal summits all the way from British Columbia to Mount Whitney; others are restricted to particular parts of the mountains, and each of the four gaps mentioned forms a barrier beyond which certain species do not pass. Therefore, in contrasting the boreal faunas and floras of Shasta with corresponding faunas and floras of the Sierra Nevada and Cascade Range it is necessary to fix definite limits to the terms employed. The term 'Sierra,' as used in the table headings and following discussion, is restricted to the lofty range extending from Mount Whitney northward a little beyond Honey Lake; the 'Cascades,' to the Cascades of Oregon. In other words, the term 'Sierra' is restricted so as *not* to include Shasta or Lassen;¹ the term 'Cascades' so as *not* to include the Cascades of Washington.

The paucity of animal and plant life on Shasta, contrasted with that of the Sierra and Cascades, has been already noted and is clearly shown in the following tables. The explanation, briefly stated, is that Shasta, on account of its aridity and relatively small area, is incapable of supporting so rich a fauna and flora as either of the extensive ranges between which it is situated. It is not assumed that all of the boreal species inhabiting Shasta were discovered by us, but in the case of the Canadian and Hudsonian mammals and birds, and the Hudsonian and Alpine plants it is believed that the number which escaped detection is too small to materially alter the results here given.²

In grouping the species for study it seems most logical to arrange the mammals, birds, and plants in two principal categories: (a) Boreal

¹The flora and fauna of Lassen are not known in sufficient detail to admit of complete comparisons in either direction; hence this mountain is omitted from consideration in the accompanying tables. At the same time it should be stated that Lassen is clearly a part of the Sierra, so far as its fauna is concerned.

²The accompanying percentages and lists of species are provisional and subject to revision. They are based on present information and will, of course, be corrected and supplemented by future field work. They are sufficiently near the truth, however, to demonstrate certain facts and warrant certain deductions and generalizations of very great interest in connection with the origin of the boreal faunas and floras of the Sierra Nevada and Cascade Range.

species that occur on Shasta, with reference to their occurrence in the Sierra or Cascades or both; and (*b*) Boreal species that occur on the Sierra or the Cascades or both, but which, so far as known, are absent from Shasta.

BOREAL SPECIES OF SHASTA CONSIDERED WITH REFERENCE TO THEIR PRESENCE OR ABSENCE IN THE SIERRA AND THE CASCADES.

The boreal mammals, birds, and plants of Shasta have been grouped in four categories: (1) species common to Shasta and the Sierra-Cascade system as a whole; (2) species common to Shasta and the Sierra, but not known from the Cascades; (3) species common to Shasta and the Cascades but not known from the Sierra, and (4) Shasta species not known from either the Sierra or the Cascades.

Thirty-six distinctively Boreal mammals are known from Shasta, including the boreal species which range down into or through the Transition zone. Of these, 26 are common to the Sierra on the south and the Cascades on the north, 7 are common to Shasta and the Sierra but are not known from the Cascades, 1 is common to Shasta and the Cascades but is not known from the Sierra, and 2 are peculiar to Shasta.

Of the 36 distinctively Boreal mammals of Shasta, 17 are believed to be exclusively boreal. Of these, 12 are common to the Sierra and the Cascades, 4 are common to Shasta and the Sierra but are not known from the Cascades, 1 is peculiar to Shasta, but not one is common to Shasta and the Cascades which does not occur also in the Sierra.

Forty-seven distinctively Boreal birds are known from Shasta, including the boreal species which range down into or through the Transition zone. Of these, 41 are common to the Sierra and the Cascades, 4 are common to Shasta and the Sierra but are not known from the Cascades, and 2 are common to Shasta and the Cascades but are not known from the Sierra.

Of the 47 distinctively Boreal birds of Shasta, 22 are believed to be exclusively boreal. Of these, 18 are common to the Sierra and the Cascades, 2 are common to Shasta and the Sierra but are not known from the Cascades, and 2 are common to Shasta and the Cascades but are not known from the Sierra.

One hundred and twelve distinctively Boreal plants are known from Shasta, including the boreal species which range down into or through the Transition zone. Of these 55 are common to the Sierra and the Cascades; 31 are common to Shasta and the Sierra but are not known from the Cascades; 16 are common to Shasta and the Cascades but are not known from the Sierra, and 8 occur on Shasta which are not known from either the Sierra or the Cascades.

Of the 112 distinctively Boreal plants of Shasta, 101 are believed to be exclusively boreal. Of these, 47 are common to the Sierra and the Cascades; 28 are common to Shasta and the Sierra but are not known

from the Cascades; 15 are common to Shasta and the Cascades but are not known from the Sierra; and 8 are restricted to Shasta.

Three mammals, 5 birds, and 68 plants are believed to be restricted to the Hudsonian and Alpine zones. Of these, 2 mammals, 3 birds, and 30 plants are common to the Sierra and the Cascades; one mammal, 1 bird, and 18 plants are common to Shasta and the Sierra but are not known from the Cascades; and no mammal, 1 bird, and 12 plants are common to Shasta and the Cascades, but are not known from the Sierra. Five Hudsonian-Alpine plants from Shasta are not known from either the Sierra or the Cascades.

These comparisons show:

(1) That of the boreal species known from Shasta, including those which range down into the Transition zone, 87 percent of the birds, 72 percent of the mammals, and only 50 percent of the plants are common to the Sierra and the Cascades.

(2) That of the exclusively boreal species known from Shasta, 85 percent of the birds, 70 percent of the mammals, and 46 percent of the plants are common to the Sierra and the Cascades.

(3) That of the exclusively Hudsonian and Alpine species known from Shasta, 60 percent of the birds, 67 percent of the mammals, and 44 percent of the plants are common to the Sierra and the Cascades.

(4) That in each instance, as would be expected, the percentage of species common to the two ranges is greater in the case of those ranging down into the Transition zone than in those restricted to the Boreal, for the obvious reason that geographically the Boreal belt is broken by broad gaps, while the Transition zone is practically continuous.

(5) That of the birds, mammals, and plants of Shasta, birds have by far the largest percentage of species common to the Sierra and the Cascades, mammals next, and plants least of all. This corresponds with the relative powers of dispersion possessed by these groups.

Arranged primarily by groups instead of zone limits, it appears that the percentages of Shasta birds common to the Sierra and the Cascades are as follows: Of boreal species, including those which range down into the Transition zone, 87 percent; of species restricted to the Boreal zones, 85 percent; of species restricted to the Hudsonian and Alpine zones, 60 percent.

The percentages of Shasta mammals common to the Sierra and the Cascades are: Of boreal species, including those which range down into the Transition zone, 72 percent; of species restricted to the Boreal zones, 70 percent; of species restricted to the Hudsonian and Alpine zones, 67 percent.¹

The percentages of Shasta plants common to the Sierra and the Cascades are: Of boreal species, including those which range down into the Transition zone, 49 percent; of species restricted to the Boreal

¹ The number of Hudsonian-Alpine species is too small to give this percentage much value.

zones, 46 percent; of species restricted to the Hudsonian and Alpine zones, 44 percent.

For evidence of another kind—that based on the *absence* from Shasta of species which occur in the Sierra or the Cascades or both—see pages 79–82.

Following are the tables on which the foregoing generalizations are based:

(1) BOREAL SPECIES COMMON TO SHASTA AND THE SIERRA-CASCADE SYSTEM.

(Species followed by the letter T range down into or through the Transition zone.)

(a) MAMMALS.

| | |
|--|--------------------------------------|
| <i>Callospermophilus chrysodeirus</i> T. | <i>Myotis yumanensis saturatus</i> . |
| <i>Canis lestes</i> . | <i>Neotoma cinerea</i> T. |
| <i>Erethizon epixanthus</i> T.? | <i>Neotrichus gibbsi major</i> T. |
| <i>Eutamias amoenus</i> T. | <i>Ochotona schisticeps</i> . |
| <i>Eutamias senex</i> T. | <i>Odocoileus columbianus</i> T. |
| <i>Eutamias mazama</i> . ¹ | <i>Peromyscus gambeli</i> T. |
| <i>Felis oregonensis</i> T. | <i>Phenacomys orophilus</i> . |
| <i>Lepus klamathensis</i> T.? | <i>Putorius arizonensis</i> . |
| <i>Lutreola vison energumenos</i> T. | <i>Sorex vagrans amoenus</i> T. |
| <i>Microtus mordax</i> T. | <i>Sorex (Neosorex) navigator</i> . |
| <i>Mustela caurina</i> . | <i>Taxidea taxus</i> T. |
| <i>Mustela pennanti</i> . | <i>Ursus americanus</i> T. |
| <i>Myotis lucifugus longicrus</i> T. | <i>Vulpes macrotus</i> T. |

(b) BIRDS.

| | |
|--|--|
| <i>Accipiter atricapillus striatulus</i> . | <i>Hylocichla aonalaschkei auduboni</i> T. |
| <i>Accipiter velox</i> . | <i>Melospiza lincolni</i> T. |
| <i>Aquila chrysaetos</i> T. | <i>Melospiza migratoria propinqua</i> T. |
| <i>Carpodacus cassinii</i> . | <i>Myadestes townsendi</i> . |
| <i>Ceophloeus pileatus abieticola</i> T. | <i>Nucifraga columbiana</i> . |
| <i>Certhia familiaris occidentalis</i> T. | <i>Oreortyx pictus plumiferus</i> T. |
| <i>Cinclus mexicanus</i> T.? | <i>Parus gambeli</i> . |
| <i>Coccothraustes vespertinus montanus</i> . | <i>Picoides arcticus</i> . |
| <i>Colaptes cafer</i> T. | <i>Piranga ludoviciana</i> T. |
| <i>Contopus borealis</i> T. | <i>Regulus calendula</i> . |
| <i>Dendragapus obscurus fuliginosus</i> T. | <i>Regulus satrapa olivaceus</i> . |
| <i>Dendroica auduboni</i> T. | <i>Salpinctes obsoletus</i> T. |
| <i>Dendroica occidentalis</i> . | <i>Selasphorus rufus</i> T. |
| <i>Dryobates villosus hyloscopus</i> T. | <i>Sialia arctica</i> . |
| <i>Empidonax difficilis</i> T. | <i>Sitta canadensis</i> . |
| <i>Empidonax hammondi</i> T. | <i>Sitta carolinensis aculeata</i> T. |
| <i>Empidonax wrighti</i> T. | <i>Sphyrapicus thyroideus</i> . |
| <i>Geothlypis tolmiei</i> T. | <i>Spinus pinus</i> . |
| <i>Helminthophila celata lutescens</i> T. | <i>Stellula calliope</i> T. |
| <i>Helminthophila rubricapilla gutturalis</i> T. | <i>Wilsonia pusilla pileolata</i> T.? |
| | <i>Zonotrichia leucophrys</i> . |

¹ *Eutamias mazama*, a common Cascade species, was obtained by us on Shasta and Lassen, and doubtless occurs in the Sierra, farther south.

(c) PLANTS.

| | |
|--|----------------------------------|
| <i>Achillea borealis.</i> | <i>Mimulus primuloides.</i> |
| <i>Aconitum columbianum.</i> | <i>Mitella pentandra.</i> |
| <i>Allium validum.</i> | <i>Oreobroma triphylla.</i> |
| <i>Alnus sinuata.</i> | <i>Orthocarpus pilosus.</i> |
| <i>Antennaria media.</i> | <i>Oxyria digyna.</i> |
| <i>Arabis platysperma.</i> | <i>Pentstemon newberryi.</i> |
| <i>Arctostaphylos nevadensis.</i> | <i>Phlox douglasii diffusa.</i> |
| <i>Bikukulla uniflora.</i> | <i>Pinus albicaulis</i> |
| <i>Cardamine bellidifolia pachyphylla.</i> | <i>Pinus monticola.</i> |
| <i>Carex breweri.</i> | <i>Pinus murrayana.</i> |
| <i>Castanopsis sempervirens</i> T. | <i>Polemonium pulchellum.</i> |
| <i>Chimaphila menziesi</i> T. | <i>Polygonum shastense.</i> |
| <i>Chimaphila umbellata</i> T. | <i>Potentilla flabellifolia.</i> |
| <i>Chrysothamnus bloomeri.</i> | <i>Pulsatilla occidentalis.</i> |
| <i>Cymopterus terebinthinus.</i> | <i>Pyrola pecta</i> T. |
| <i>Drosera rotundifolia.</i> | <i>Pyrola secunda</i> T. |
| <i>Epilobium obovatum.</i> | <i>Ribes cereum</i> T. |
| <i>Epilobium pringleanum.</i> | <i>Sagina saginoides.</i> |
| <i>Eriogonum pyrolae-folium.</i> | <i>Salix nuttalli</i> T. |
| <i>Gentiana simplex.</i> | <i>Salix sitchensis</i> T. |
| <i>Habenaria leucostachys.</i> | <i>Saxifraga tolmiei.</i> |
| <i>Habenaria unalaschensis.</i> | <i>Sibbaldia procumbens.</i> |
| <i>Heracleum lanatum</i> T. | <i>Sorbus sambucifolia</i> T. |
| <i>Holodiscus discolor.</i> | <i>Spraguea umbellata.</i> |
| <i>Hypericum anagalloides.</i> | <i>Tsuga mertensiana.</i> |
| <i>Junens parryi.</i> | <i>Viola blanda.</i> |
| <i>Juniperus nana.</i> | <i>Viola purpurea.</i> |
| <i>Kalmia glauca microphylla.</i> | |

(2) BOREAL SPECIES COMMON TO SHASTA AND THE SIERRA BUT NOT KNOWN FROM THE CASCADES.

(a) MAMMALS.

Aplodontia major (represented in Cascades by *A. major rainieri*).
Ovis canadensis (not known or represented in Cascades).
Peromyscus boylii T. (not known or represented in Cascades).
Sciurus albolimbatus T. (represented in Cascades by *S. cascadenensis*).
Sorex montereyensis T. (not known from any point north of Shasta).
Thomomys monticola (represented in Cascades by *T. mazama*).
Zapus trinotatus adeni (represented in Cascades by *Z. montanus*).

(b) BIRDS.

Cyanocitta stelleri frontalis T. (represented in Cascades by *C. stelleri*).¹
Junco hyemalis thurberi (represented in Cascades by *J. h. connectens*).
*Leucosticte tephrocotis*² (represented in Cascades by *L. t. littoralis*).
Loxia curvirostra bendirei (represented in Cascades by *L. c. minor*).

¹ The Shasta jay is intermediate between *stelleri* and *frontalis*.

² The mention of *Leucosticte tephrocotis* in this and subsequent lists involves an assumption. *L. tephrocotis* is known to be the breeding rosy finch of the High Sierra; *L. t. littoralis* that of Mount Rainier in the Cascades of Washington. A rosy finch was found, but not secured, on Shasta. It is referred provisionally to *tephrocotis* rather than *littoralis*, because the great majority of Shasta species which are not common to both ranges are Sierra and not Cascade forms.

BOREAL SPECIES OF SHASTA AND SIERRA—Continued.

(c) PLANTS.

| | |
|--|--|
| <i>Agoseris monticola.</i> | <i>Hieracium albidiflorum</i> (alpine form). |
| <i>Arnica merriami.</i> | <i>Hieracium horridum.</i> |
| <i>Castilleja affinis.</i> | <i>Hulsea larseni.</i> |
| <i>Castilleja miniata</i> (alpine form). | <i>Madia bolanderi.</i> |
| <i>Chenactis nevadensis.</i> | <i>Parnassia californica.</i> |
| <i>Cheiranthus perennis.</i> | <i>Pentstemon gracilentus.</i> |
| <i>Corallorhiza bigelovi.</i> | <i>Ribes amictum</i> T. |
| <i>Crepis intermedia.</i> | <i>Saxifraga bryophora.</i> |
| <i>Cycladenia humilis.</i> | <i>Senecio canus.</i> |
| <i>Delphinium sonnei.</i> | <i>Senecio trigonophyllus.</i> |
| <i>Draba breweri.</i> | <i>Stellaria crispa.</i> |
| <i>Erigeron armeriaefolium.</i> | <i>Streptanthus orbiculatus.</i> |
| <i>Erigeron compositus trifidus.</i> | <i>Vaccinium caespitosum.</i> |
| <i>Erigeron inornatus.</i> | <i>Vagnera stellata</i> T. |
| <i>Eriogonum polypodium.</i> | <i>Veratrum californicum</i> T. |

(3) BOREAL SPECIES COMMON TO SHASTA AND THE CASCADES BUT NOT KNOWN FROM THE SIERRA.

(a) MAMMALS.

Cervus occidentalis T.

(b) BIRDS.

| | |
|------------------------------|-----------------------------|
| <i>Anthus pensilvanicus.</i> | <i>Perisoreus obscurus.</i> |
|------------------------------|-----------------------------|

(c) PLANTS.

| | |
|-----------------------------------|----------------------------------|
| <i>Abies shastensis.</i> | <i>Oreastrum alpinum.</i> |
| <i>Epilobium clavatum.</i> | <i>Pentstemon menziesi.</i> |
| <i>Hieracium gracile.</i> | <i>Phyllodoce empetrifloris.</i> |
| <i>Hulsea nana.</i> | <i>Polygonum newberryi.</i> |
| <i>Ligusticum grayi.</i> | <i>Silene suksdorfii.</i> |
| <i>Lupinus lyalli.</i> | <i>Tofieldia occidentalis.</i> |
| <i>Lupinus 'ornatus.'</i> | <i>Vaccinium arbuscula</i> T. |
| <i>Lutkea pectinata.</i> | <i>Veronica cusicki.</i> |
| <i>Machaeranthera shastensis.</i> | |

(4) BOREAL SHASTA SPECIES NOT KNOWN FROM EITHER THE SIERRA OR THE CASCADES.

(a) MAMMALS.

| | |
|------------------------------------|--------------------------|
| <i>Perognathus mollipilosus</i> T. | <i>Sorex shastensis.</i> |
|------------------------------------|--------------------------|

(b) BIRDS.

[None.]

(c) PLANTS.

| | |
|--|---------------------------------------|
| <i>Arnica longifolia.</i> | <i>Pentstemon glaber utahensis.</i> |
| <i>Arnica viscosa.</i> ¹ | <i>Phacelia frigida.</i> ¹ |
| <i>Campanula wilkinsiana.</i> ¹ | <i>Scutellaria nana.</i> |
| <i>Mimulus implexus.</i> | <i>Silene grayi.</i> ¹ |

¹ So far as known restricted to Shasta.

(5) EXCLUSIVELY BOREAL SPECIES OF SHASTA.

(a) MAMMALS.

| | |
|--------------------------------------|-------------------------------------|
| <i>Aplodontia major</i> . | <i>Ovis canadensis</i> . |
| <i>Canis lestes</i> . | <i>Phenacomys orophilus</i> . |
| <i>Evotomys mazama</i> . | <i>Putorius arizonensis</i> . |
| ? <i>Lepus klamathensis</i> . | <i>Sorex (Neosorex) navigator</i> . |
| <i>Microtus mordax</i> . | <i>Sorex shastensis</i> . |
| <i>Mustela caurina</i> . | <i>Thomomys monticola</i> . |
| <i>Mustela pennanti</i> . | <i>Vulpes macrourus</i> . |
| <i>Myotis yumanensis saturatus</i> . | <i>Zapus trinotatus alleni</i> . |
| <i>Ochotona schisticeps</i> . | |

(b) BIRDS.

| | |
|--|-------------------------------------|
| <i>Accipiter atricapillus striatulus</i> . | <i>Parus gambeli</i> . |
| <i>Anthus pensilvanicus</i> . | <i>Perisoreus obscurus</i> . |
| <i>Carpodacus cassinii</i> . | <i>Picoides arcticus</i> . |
| <i>Cinclus mexicanus</i> . | <i>Regulus calendula</i> . |
| <i>Coccothraustes vespertinus montanus</i> . | <i>Regulus satrapa olivaceus</i> . |
| <i>Dendroica occidentalis</i> . | <i>Sialia arctica</i> . |
| <i>Junco hyemalis thurberi</i> . | <i>Sitta canadensis</i> . |
| <i>Leucosticte tephrocotis</i> . | <i>Sphyrapicus thyroideus</i> . |
| <i>Loxia curvirostra bendirei</i> . | <i>Spinus pinus</i> . |
| <i>Myadestes townsendi</i> . | <i>Wilsonia pusilla pileolata</i> . |
| <i>Nucifraga columbiana</i> . | <i>Zonotrichia leucophrys</i> . |

(c) PLANTS.

| | |
|---|--|
| <i>Abies shastensis</i> . | <i>Epilobium oboordatum</i> . |
| <i>Achillea borealis</i> . | <i>Epilobium pringleanum</i> . |
| <i>Aconitum columbianum</i> . | <i>Erigeron armeriaefolium</i> . |
| <i>Agoseris monticola</i> . | <i>Erigeron compositus trifidus</i> . |
| <i>Allium validum</i> . | <i>Erigeron inornatus</i> . |
| <i>Allium</i> sp. —? | <i>Eriogonum polypodium</i> . |
| <i>Alnus sinuata</i> . | <i>Eriogonum pyrolaefolium</i> . |
| <i>Antennaria media</i> . | <i>Gentiana simplex</i> . |
| <i>Arabis platysperma</i> . | <i>Habenaria leucostachys</i> . |
| <i>Arctostaphylos nevadensis</i> . | <i>Habenaria unalaschensis</i> . |
| <i>Arnica longifolia</i> . | <i>Hieracium albidiflorum</i> (alpine form). |
| <i>Arnica merriami</i> . | <i>Hieracium gracile</i> . |
| <i>Arnica viscosa</i> . | <i>Hieracium horridum</i> . |
| <i>Biskakulla uniflora</i> . | <i>Holodiscus discolor</i> . |
| <i>Campanula wilkinsiana</i> . | <i>Hulsea larseni</i> . |
| <i>Cardamine bellidifolia pachyphylla</i> . | <i>Hulsea nana</i> . |
| <i>Carex breweri</i> . | <i>Hypericum anagalloides</i> . |
| <i>Castilleja miniata</i> (alpine form). | <i>Juncus parryi</i> . |
| <i>Chaenactis nevadensis</i> . | <i>Juniperus nana</i> . |
| <i>Cheiranthus perennis</i> . | <i>Kalmia glauca microphylla</i> . |
| <i>Chrysothamnus bloomeri</i> . | <i>Ligusticum grayi</i> . |
| <i>Corallorhiza bigelovi</i> . | <i>Lupinus albifrons</i> . |
| <i>Crepis intermedia</i> . | <i>Lupinus lyalli</i> . |
| <i>Cycladenia humilis</i> . | <i>Lupinus 'ornatus'</i> . |
| <i>Cymopterus terebinthinus</i> . | <i>Lutkea pectinata</i> . |
| <i>Delphinium sonnei</i> . | <i>Machaeranthera shastensis</i> . |
| <i>Draba breweri</i> . | <i>Madia bolanderi</i> . |
| <i>Drosera rotundifolia</i> . | <i>Mimulus implexus</i> . |
| <i>Epilobium clavatum</i> . | <i>Mimulus primuloides</i> . |

EXCLUSIVELY BOREAL SPECIES OF SHASTA—Continued.

(c) PLANTS—continued.

| | |
|-------------------------------------|------------------------------------|
| <i>Mitella pentandra.</i> | <i>Potentilla pseudorupestris.</i> |
| <i>Monardella odoratissima.</i> | <i>Pulsatilla occidentalis.</i> |
| <i>Oreastrum alpinum.</i> | <i>Sagina saginoides.</i> |
| <i>Oreobroma triphylla.</i> | <i>Saxifraga bryophora.</i> |
| <i>Orthocarpus pilosus.</i> | <i>Saxifraga tolmiei.</i> |
| <i>Oxyria digyna.</i> | <i>Senecio canus.</i> |
| <i>Parnassia californica.</i> | <i>Senecio trigonophyllus.</i> |
| <i>Pentstemon densus.</i> | <i>Sibbaldia procumbens.</i> |
| <i>Pentstemon glaber utahensis.</i> | <i>Silene grayi.</i> |
| <i>Pentstemon gracilentus.</i> | <i>Silene suksdorfii.</i> |
| <i>Pentstemon menziesi.</i> | <i>Sitanion cinereum.</i> |
| <i>Pentstemon newberryi.</i> | <i>Spraguea umbellata.</i> |
| <i>Phacelia frigida.</i> | <i>Stellaria crispa.</i> |
| <i>Phlox douglasi diffusa.</i> | <i>Streptanthus orbiculatus.</i> |
| <i>Phylodoce empetrifolia.</i> | <i>Tofieldia occidentalis.</i> |
| <i>Pinus albicaulis.</i> | <i>Tsuga mertensiana.</i> |
| <i>Pinus monticola.</i> | <i>Vaccinium caespitosum.</i> |
| <i>Pinus murrayana.</i> | <i>Vaccinium occidentale.</i> |
| <i>Polemonium pulchellum.</i> | <i>Veronica cusicki.</i> |
| <i>Polygonum newberryi.</i> | <i>Viola blanda.</i> |
| <i>Polygonum shastense.</i> | <i>Viola purpurea.</i> |
| <i>Potentilla flabellifolia.</i> | |

(6) EXCLUSIVELY HUDSONIAN-ALPINE SPECIES OF SHASTA.

MAMMALS.

| | |
|------------------------------|------------------------------|
| <i>Ochotona schisticeps.</i> | <i>Phenacomys orophilus.</i> |
| <i>Ovis canadensis.</i> | |

BIRDS.

| | |
|---------------------------------|--------------------------------|
| <i>Anthus pensilvanicus.</i> | <i>Sialia arctica.</i> |
| <i>Leucosticte tephrocotis.</i> | <i>Zonotrichia leucophrys.</i> |
| <i>Nucifraga columbiana.</i> | |

PLANTS.

| | |
|--|--|
| <i>Achillea borealis.</i> | <i>Eriogonum polypodium.</i> |
| <i>Agoseris monticola.</i> | <i>Eriogonum pyrolaefolium.</i> |
| <i>Antennaria media.</i> | <i>Hieracium albidiflorum</i> (alpine form). |
| <i>Arabis platysperma.</i> | <i>Hieracium gracile.</i> |
| <i>Arnica merriami.</i> | <i>Hieracium horridum.</i> |
| <i>Arnica viscosa.</i> | <i>Holodiscus discolor</i> (alpine form). |
| <i>Bikukulla uniflora.</i> | <i>Hulsea larseni.</i> |
| <i>Cardamine bellidifolia pachyphylla.</i> | <i>Hulsea nana.</i> |
| <i>Carex breweri.</i> | <i>Juncus parryi.</i> |
| <i>Chamaetis nevadensis.</i> | <i>Juniperus nana.</i> |
| <i>Cheiranthus perennis.</i> | <i>Kalmia glauca microphylla.</i> |
| <i>Chrysothamnus bloomeri.</i> | <i>Lupinus albifrons.</i> |
| <i>Cycladenia humilis.</i> | <i>Lupinus lyalli.</i> |
| <i>Cymopterus terebinthinus.</i> | <i>Lupinus 'ornatus.'</i> |
| <i>Draba breweri.</i> | <i>Lutkea pectinata.</i> |
| <i>Epilobium clavatum.</i> | <i>Machaeranthera shastensis.</i> |
| <i>Epilobium obovatum.</i> | <i>Mimulus implexus.</i> |
| <i>Epilobium pringleanum.</i> | <i>Mitella pentandra.</i> |
| <i>Erigeron armeriaefolium.</i> | <i>Oreastrum alpinum.</i> |
| <i>Erigeron compositus trifidus.</i> | <i>Oreobroma triphylla.</i> |

EXCLUSIVELY HUDSONIAN-ALPINE SPECIES OF SHASTA—Continued.

PLANTS—continued.

| | |
|--------------------------------------|-----------------------------------|
| <i>Orthocarpus pilosus</i> . | <i>Pulsatilla occidentalis</i> . |
| <i>Oxyria digyna</i> . | <i>Sagina saginoides</i> . |
| <i>Parnassia californica</i> . | <i>Saxifraga bryophora</i> . |
| <i>Pentstemon glaber utahensis</i> . | <i>Saxifraga tolmiei</i> . |
| <i>Pentstemon menziesi</i> . | <i>Senecio canus</i> . |
| <i>Pentstemon newberryi</i> . | <i>Sibbaldia procumbens</i> . |
| <i>Phacelia frigida</i> . | <i>Silene grayi</i> . |
| <i>Phyllodoce empetrifloris</i> . | <i>Silene suksdorti</i> . |
| <i>Pinus albicaulis</i> . | <i>Sitanion cinereum</i> . |
| <i>Polemonium pulchellum</i> . | <i>Streptanthus orbiculatus</i> . |
| <i>Polygonum newberryi</i> . | <i>Tsuga mertensiana</i> . |
| <i>Polygonum shastense</i> . | <i>Vaccinium caespitosum</i> . |
| <i>Potentilla flabellifolia</i> . | <i>Veronica cusicki</i> . |
| <i>Potentilla pseudorupetris</i> . | <i>Viola purpurea</i> . |

(7) EXCLUSIVELY HUDSONIAN-ALPINE SPECIES COMMON TO SHASTA AND THE SIERRA-CASCADE SYSTEM.

MAMMALS.

| | |
|-------------------------------|-------------------------------|
| <i>Ochotona schisticeps</i> . | <i>Phenacomys orophilus</i> . |
|-------------------------------|-------------------------------|

BIRDS.

| | |
|-------------------------------|---------------------------------|
| <i>Neiofraga columbiana</i> . | <i>Zonotrichia leucophrys</i> . |
| <i>Sialia arctica</i> . | |

PLANTS.

| | |
|---|-----------------------------------|
| <i>Achillea borealis</i> . | <i>Mitella pentandra</i> . |
| <i>Antennaria media</i> . | <i>Oreobroma triphylla</i> . |
| <i>Arabis platysperma</i> . | <i>Orthocarpus pilosus</i> . |
| <i>Biskakulla uniflora</i> . | <i>Oxyria digyna</i> . |
| <i>Cardamine bellidifolia pachyphylla</i> . | <i>Pentstemon newberryi</i> . |
| <i>Carex breweri</i> . | <i>Pinus albicaulis</i> . |
| <i>Chrysothamnus bloomeri</i> . | <i>Polemonium pulchellum</i> . |
| <i>Cynopterus terebinthinus</i> . | <i>Polygonum shastense</i> . |
| <i>Epilobium obcordatum</i> . | <i>Potentilla flabellifolia</i> . |
| <i>Epilobium pringleanum</i> . | <i>Pulsatilla occidentalis</i> . |
| <i>Eriogonum pyrolæfolium</i> . | <i>Sagina saginoides</i> . |
| <i>Holodiscus discolor</i> (typical alpine form). | <i>Saxifraga tolmiei</i> . |
| <i>Juncus parryi</i> . | <i>Sibbaldia procumbens</i> . |
| <i>Juniperus nana</i> . | <i>Tsuga mertensiana</i> . |
| <i>Kalmia glauca microphylla</i> . | <i>Viola purpurea</i> . |

(8) EXCLUSIVELY HUDSONIAN-ALPINE SPECIES COMMON TO SHASTA AND THE SIERRA BUT NOT KNOWN FROM THE CASCADES.

MAMMALS.

Ovis canadensis.

BIRDS.

? *Leucosticte tephrocotis*.

PLANTS.

| | |
|-------------------------------|---------------------------------------|
| <i>Agoseris monticola</i> . | <i>Cycladenia humilis</i> . |
| <i>Arnica merriami</i> . | <i>Draba breweri</i> . |
| <i>Chenactis nevadensis</i> . | <i>Erigeron armeriaefolium</i> . |
| <i>Cheiranthus perennis</i> . | <i>Erigeron compositus trifidus</i> . |

HUDSONIAN-ALPINE SPECIES OF SHASTA AND SIERRA—Continued.

PLANTS—continued.

| | |
|--|----------------------------------|
| <i>Eriogonum polypodium.</i> | <i>Saxifraga bryophora.</i> |
| <i>Hieracium albiflorum</i> (alpine form). | <i>Senecio canus.</i> |
| <i>Hieracium horridum.</i> | <i>Streptanthus orbiculatus.</i> |
| <i>Hulsea larseni.</i> | <i>Vaccinium caespitosum.</i> |
| <i>Parnassia californica.</i> | |

(9) EXCLUSIVELY HUDSONIAN-ALPINE SPECIES COMMON TO SHASTA AND THE CASCADES BUT NOT KNOWN FROM THE SIERRA.

MAMMALS.

None.

BIRDS.

Anthus pensilvanicus.

PLANTS.

| | |
|---------------------------------|---------------------------------|
| <i>Epilobium clavatum.</i> | <i>Oreastrum alpinum.</i> |
| <i>Hieracium gracile.</i> | <i>Pentstemon menziesi.</i> |
| <i>Hulsea nana.</i> | <i>Phyllodoce empetrifomis.</i> |
| <i>Lupinus lyalli.</i> | <i>Polygonum newberryi.</i> |
| <i>Lupinus 'ornatus.'</i> | <i>Silene suksdorfii.</i> |
| <i>Lutkea pectinata.</i> | <i>Veronica cusickii.</i> |
| <i>Machæranthra shastensis.</i> | |

BOREAL SPECIES OF THE SIERRA-CASCADES NOT KNOWN FROM SHASTA.

Turning to another phase of the subject, the *absentees*, or boreal species of the Sierra and Cascades which are not known from Shasta, an equally instructive lesson may be learned.

The boreal species that occur in the Sierra or Cascades, or both, but which are not known from Shasta, have been grouped in three categories: (1) species common to the Sierra-Cascades but not known from Shasta; (2) Sierra species not known from Shasta or the Cascades; and (3) Cascade species not known from Shasta or the Sierra.¹

(1) BOREAL SPECIES COMMON TO THE SIERRA AND THE CASCADES BUT NOT KNOWN FROM SHASTA.

Only three boreal mammals are known to occur in both the Sierra and the Cascades which have not been found on Shasta. These are the Sierra marmot (*Arctomys flaviventer*), the wolverine (*Gulo luscus*), and the silver-haired bat (*Lasiomycteris noctiragans*). The marmot, it may be stated with confidence, is really absent; the wolverine has been killed in the near vicinity and probably occurs on Shasta; the bat is a local species common in the mountains west of Shasta, easily overlooked and most likely to occur. Hence there is every reason to

¹ In the accompanying tables and discussion the boreal species are treated collectively, no account being taken of the important distinctions between the Alpine, Hudsonian, and Canadian species. This course has been rendered necessary by the absence of discriminative zone lists of Cascade-Sierra species.

believe that the Sierra marmot is really the only mammal common to the Sierra and the Cascades which does not occur on Shasta.

Two boreal birds believed to be common to the Sierra-Cascade system (the western winter wren, *Anorthura hiemalis pacifica*, and the Townsend warbler, *Dendroica townsendi*) have not yet been discovered on Shasta, but are liable to be found there at any time.

With plants the case is quite different, for at least 19 well-known genera, and a considerable number of species of other genera, not known from Shasta are common to the Sierra and the Cascades.

(a) MAMMALS.

Arctomys flaviventer. *Gulo luscus.* *Lasionyxeteris noctivagans.*

(b) BIRDS.

Anorthura hiemalis pacifica. *Dendroica townsendi.*

(c) PLANTS.

Genera not known from Shasta.

| | | |
|---------------------|----------------------|---------------------|
| <i>Arenaria.</i> | <i>Iris.</i> | <i>Ranunculus.</i> |
| <i>Cassiope.</i> | <i>Ivesia.</i> | <i>Smelowskia.</i> |
| <i>Claytonia.</i> | <i>Listera.</i> | <i>Streptopus.</i> |
| <i>Clintonia.</i> | <i>Mertensia.</i> | <i>Thalictrum.</i> |
| <i>Erythronium.</i> | <i>Pedicularis.</i> | <i>Xerophyllum.</i> |
| <i>Geum.</i> | <i>Primula.</i> | |
| <i>Henckera.</i> | <i>Raillardella.</i> | |

Additional species not known from Shasta.

| | |
|-------------------------------|--------------------------------|
| <i>Arnica chamissonis.</i> | <i>Lonicera involucrata.</i> |
| <i>Campanula scouleri.</i> | <i>Polygonum bistortoides.</i> |
| <i>Crepis nana.</i> | <i>Populus tremuloides.</i> |
| <i>Erigeron salsuginosus.</i> | <i>Salix barelayi.</i> |
| <i>Gentiana newberryi.</i> | <i>Saxifraga nivalis.</i> |
| <i>Juncus orthophyllus.</i> | <i>Saxifraga punctata.</i> |
| <i>Lonicera conjungalis.</i> | |

(2) BOREAL SIERRA SPECIES NOT KNOWN FROM SHASTA OR THE CASCADES.

Eight mammals, 1 bird, 3 coniferous trees, several shrubs, and a number of small plants are known from the High Sierra which do not occur on Shasta or the Cascades; the majority of them are restricted to the southern part of the Sierra, not reaching as far north as the mountains about Lake Tahoe, and consequently need not be considered here. Only three of the Sierra mammals (*Spermophilus beldingi*, *Eutamias speciosus frater*, and *Sorex obscurus*) which range north to the south end of Feather River Gap fail to reach Shasta, and two if not all three of these are known to cross this gap and occur on Lassen, showing that the Feather River Gap of itself is of very little significance. The details of plant distribution in these mountains are not sufficiently known to admit of safe generalizations.

BOREAL SIERRA SPECIES—Continued.

(a) MAMMALS.

| | |
|--|---|
| <i>Eutamias alpinus</i> . ¹ | <i>Microtus dutcheri</i> . ¹ |
| <i>Eutamias speciosus</i> . ¹ | <i>Sorex obscurus</i> . |
| <i>Eutamias speciosus callipeplus</i> . ¹ | <i>Spermophilus beldingi</i> . |
| <i>Eutamias speciosus frater</i> . | <i>Thomomys alpinus</i> . ¹ |

(b) BIRDS.

Pinicola enucleator californica.

(c) PLANTS.

| | |
|-------------------------------|--------------------------------|
| <i>Abies magnifica</i> . | <i>Oreobroma nevadensis</i> . |
| <i>Arenaria compacta</i> . | <i>Oreobroma pygmaea</i> . |
| <i>Arenaria congesta</i> . | <i>Phyllodoce breweri</i> . |
| <i>Artemisia rothrockii</i> . | <i>Pinus balfouriana</i> . |
| <i>Chrysopsis breweri</i> . | <i>Pinus flexilis</i> . |
| <i>Draba lemmoni</i> . | <i>Primula suffrutescens</i> . |
| <i>Eulophus parishii</i> . | <i>Quercus vaccinifolia</i> . |
| <i>Hulsea algida</i> . | <i>Raillardella scaposa</i> . |
| ? <i>Ledum glandulosum</i> . | <i>Ranunculus oxynotus</i> . |
| <i>Leucothoe davisiae</i> . | <i>Silene bernardina</i> . |
| <i>Lychnis californica</i> . | <i>Silene californica</i> . |
| <i>Montia fontana</i> . | |

(3) BOREAL CASCADE SPECIES NOT KNOWN FROM SHASTA OR THE SIERRA.

Eleven mammals, 2 birds, 3 fir trees, and a number of shrubs and other plants which inhabit the Cascade Range in Oregon are not known to occur on Shasta or in the Sierra Nevada. One of the mammals (*Eutamias townsendi*) does not reach as far south as the southern end of the Cascades, and two others (*Aplodontia major rainieri* and *Sciurus cascadenensis*) are only subspecifically separable from corresponding forms in the Sierra. The remaining eight are independent specific types not represented on Shasta or in the Sierra, and all of them push south to the extreme southern end of the Cascades immediately across Klamath Gap from Shasta.

(a) MAMMALS.

| | |
|---|---|
| <i>Aplodontia major rainieri</i> . | <i>Scapanus alpinus</i> . |
| <i>Eutamias townsendi</i> . | <i>Sciurus douglasi cascadenensis</i> . |
| <i>Lynx canadensis</i> . | <i>Sorex (Atophyrax) bendirei</i> . |
| <i>Microtus (Arvicola) arvicoloides</i> . | <i>Thomomys mazama</i> . |
| <i>Microtus (Chilotus) bairdi</i> . | <i>Zapus montanus</i> . |
| <i>Putorius cicognani streatori</i> . | |

(b) BIRDS.

| | |
|------------------------------|--|
| <i>Holocichla ustulata</i> . | <i>Leucosticte tephrocotis littoralis</i> . ² |
|------------------------------|--|

¹ These mammals are restricted to the southern part of the Sierra and none of them come as far north as the mountains about Lake Tahoe.

² *Leucosticte tephrocotis littoralis* breeds in the Cascades of Washington but is not actually known from the Cascades of Oregon. It is likely to be found among the glaciers of Mount Hood and The Sisters when the birds of these mountains are studied.

(c) PLANTS.

Abies amabilis.
Abies lasiocarpa.
Abies nobilis.
Gaultheria myrsinites.
Menziesia ferruginea.
Rhododendron albiglorum.
Ribes erythrocarpum.

Ribes lacustre.
Rubus lasiococcus.
Silene acaulis.
Sorbus occidentalis.
Spiraea arbuscula.
Vaccinium microphyllum.
Valeriana sitchensis.

EFFICIENCY OF KLAMATH GAP AS A BARRIER TO BOREAL SPECIES COMPARED WITH THAT OF PITT RIVER AND FEATHER RIVER GAPS COLLECTIVELY.

In view of the narrowness of Klamath Gap, a break of less than 50 miles, separating the boreal fauna of Shasta from that of the Cascades, compared with the breadth of the combined Pitt River and Feather River gaps, about 100 miles, separating Shasta from the boreal fauna of the Sierra Nevada northwest of Honey Lake, one might expect Shasta to share more species with the Cascades than with the Sierra. The contrary is true. The Feather River Gap, as elsewhere explained (p. 70), is ineffective compared with the others; the branches of Feather River do not cut completely through the mountains, and the gap is merely a low part of the range, with the Honey Lake ridge and small boreal-capped peaks projecting here and there as stepping stones between the main Sierra and Mount Lassen. Pitt River Gap is deeper, cutting completely through the range between Lassen and Shasta, forming a boreal break about 60 miles in width, and there is no apparent reason why it should not be as effective a barrier as Klamath Gap, although from the standpoint of zone distribution it does not cut so low and therefore has a slightly cooler summer climate, in consequence of which it is less effective. But this difference is insufficient to explain the really great disparity in potency of the two, for in checking the extension of boreal species Klamath Gap has proved far more effective.

Passing over the species common to Shasta and the Sierra-Cascade system as a whole (see p. 73), only three of the ten distinctively Sierra mammals which reach the northern end of the Sierra fail to reach Shasta, and two if not all of these bridge the Feather River Gap and reach Mount Lassen, which is separated from Shasta by only the Pitt River Gap. On the other hand, *not one of the ten* distinctively Cascade mammals which occur at the extreme south end of the Cascade Range has been able to cross the narrow Klamath Gap to Shasta.

If the number of distinctive mammals of the Sierra-Cascade system be reduced by subtracting those which are represented in the two ranges by closely related forms¹ 8 distinctive specific types will remain

¹Close discrimination of species and subspecies is necessary in laying off the minor subdivisions of faunas; and it is interesting from the zoological standpoint to know which and how many of the specific types common to a given area have undergone enough change in parts of that area to warrant separate recognition by name, but from the standpoint of the distribution of specific types such details are of little value.

for the southern Cascades and 7 for the northern Sierra. Of these distinctive specific types only 3 of the 7 Sierra species fail to reach Shasta, while all of the 8 Cascade species fail.

The significance of these facts appears when the Boreal faunas of the mountains north and south of Klamath Gap are studied with reference to their geographic sources of origin, as pointed out in the next chapter.

SOURCES OF THE BOREAL FAUNAS OF SHASTA AND OF THE SIERRA AND THE CASCADES.

The boreal animals and plants of the Sierra-Cascade system as a whole are not yet well enough known to admit of positive statements as to the number of species or the details of their distribution. Hence a complete study of their distribution with reference to the geographic source of origin of the various specific types is not possible. Nevertheless, enough has been learned to point to some very interesting conclusions.

It has been already shown that the boreal fauna and flora of Shasta form a part of the fauna and flora of the Sierra-Cascade system; that 70 percent of the exclusively boreal mammals of Shasta are common to both ranges; and that of the remainder, 80 percent are common to the Sierra. It is obvious therefore that, so far as mammals are concerned, Shasta may be considered a part of the Sierra (see p. 71).

Fifty-eight boreal¹ species of mammals are known from the Sierra and the Cascades. Of these, 31 (54 percent) are common to both ranges, 11 (19 percent) are restricted to the Sierra, and 16 (28 percent) to the Cascades.

Of the 58 boreal species of mammals known to inhabit the Sierra-Cascade system not a single genus or subgenus is peculiar, though the genera *Aplodontia* and *Neurotrichus* and the subgenus *Atophyrax* are restricted to the northwest coast region. With species the case is very different, for 23 of the 58 species (40 percent) are peculiar to the Sierra-Cascades; but even of these only 10 differ sufficiently from near relatives elsewhere to be considered distinct specific types. Of the 58 species whose relationships are so obvious that there can be no doubt as to their affinities and origin, 5 (9 percent) come from mountains farther north (in British Columbia, some ranging into southeastern Alaska), 8 (14 percent) are of general transcontinental boreal distribution, 16 (28 percent) are characteristic of the humid west or northwest coast region, 19 (33 percent) are identical with or closely related to species living in the Rocky Mountains, and 10 (17 percent) are distinctive superspecific types restricted to the Sierra-Cascade system.

If, instead of treating the Sierra-Cascade species collectively, we group them with reference to the particular part of the mountains they inhabit, putting the Cascade species (those north of Klamath Gap) in

¹Our collections from the Cascades have not yet been worked up, and it is probable that several species will be added to this number.

one category, and the Sierra species (those south of Klamath Gap) in another, some additional facts are brought out which emphasize the widely different sources of origin of the distinctively Cascade species on the one hand, and the distinctively Sierra species on the other. Of the distinctively Cascade species, 25 percent are derived from mountains farther north, 12 percent are local types, 12 percent belong to transcontinental boreal types, and 25 percent to northwest-coast types. Of the distinctively Sierra species, 50 percent are specially developed local types, and 50 percent belong to types common to the Sierra and the southern Rocky Mountains.

These facts point not only to the great antiquity and effectiveness of the Klamath Gap, but also to a former east and west continuity of range of Boreal species between the Rocky Mountains of Utah and Colorado and the Sierra Nevada of California, a distance of at least 500 miles.

MAMMALS OF SHASTA.

Sorex shastensis sp. nov. Shasta Shrew.

Type from Wagon Camp, Mount Shasta (alt. 5,700 ft. in the lower part of the Canadian zone). No. 95450, U. S. Nat. Mus., Biological Survey Coll. Collected Sept. 26, 1898, by W. H. Osgood. Orig. No. 317.

Characters.—Size small; decidedly smaller than *S. vagrans*; tail rather short; ears small, but conspicuous. Third unicuspid smaller than fourth. Skull and teeth peculiar.

Color.—Type specimen, in change from summer to winter pelage: Head and sides of neck to shoulders dull fulvous brown; rest of upper parts dark steel gray; underparts ashy brown; tail sharply bicolor, dusky above, buffy below, becoming dusky toward tip.

Cranial characters.—Skull small, decidedly smaller than in *vagrans* and as small as in *californicus*; brain case moderately high—not at all flattened as in *californicus*; rostrum rather small (about as in *californicus*); constriction swollen. Tooth row, as a whole, somewhat shorter than in *californicus*; unicuspids decidedly narrower, particularly the first and second; molariform series much as in *californicus*, but slightly smaller; large premolar very broad posteriorly.

Measurements.—Type: Total length, 90; tail vertebrae, 35; hind foot, 12.

Remarks.—This new species is based on a single specimen caught by W. H. Osgood in a trap set in a springy place among the Shasta firs, immediately above Wagon Camp. In the same trap, and in the identical spot, he caught also specimens of *Neosorex navigator* and *Neurotrichus gibbsi major*. Several specimens of *Sorex vagrans amoenus* were caught near by, but no others of this species.

Sorex shastensis is a small shrew of uncertain affinities. In several respects it resembles *S. californicus*, but differs from this species markedly in color, and still more in the form of the cranium and narrowness of the unicuspidate teeth.

Sorex vagrans amoenus Merriam. Sierra Shrew.

Twenty-two specimens of this small shrew were collected on Shasta and about its base. Two were caught among the tules at Big Spring, in Shasta Valley, on the north side of the mountain; two at Warm-castle Soda Springs, in Squaw Creek Valley, on the south side; and nineteen in the Canadian zone and lower part of the Hudsonian from Wagon Camp up to upper Squaw Creek, Mud Creek, and Ash Creek. Most of them were trapped under logs in damp places.

Sorex montereyensis Merriam. Monterey Shrew.

Six specimens of this large long-tail shrew were secured—one at the lower edge of the Hudsonian zone, near Mud Creek; four in the Canadian zone, in Mud Creek Canyon; and one in the Transition zone, in Squaw Creek Valley, near Warmcastle Soda Springs.

Sorex (Neosorex) navigator Baird. White-bellied Water-shrew.

Apparently rather scarce, as a large amount of trapping resulted in the capture of only four specimens. These were obtained at as many localities, namely, the head of Panther Creek, upper Squaw Creek, upper Ash Creek Canyon, and Wagon Camp, all in the Canadian zone.

Neurotrichus gibbsi major subsp. nov. Large Shrewmole.

Type from Carberry Ranch, Shasta County, Calif. (alt. 4,100 ft., between Mts. Shasta and Lassen). No. 65321. ♂ ad., U. S. Nat. Mus., Biological Survey Coll. Collected May 18, 1894, by C. P. Streater. Orig. No. 3789.

Characters.—Similar to *N. gibbsi*, but decidedly larger; hind feet larger; forefeet much broader and longer; tail much longer; under parts darker; skull larger and broader; fifth upper lateral tooth (the 'large premolar') decidedly *smaller* than in *N. gibbsi*, and possessing a distinct anterior cusp on the cingulum, which is absent in *gibbsi*; fifth lower lateral tooth (the 'large premolar') decidedly *larger* than in *gibbsi*.

Measurements.—Average of 3 specimens from type locality: Total length, 120; tail vertebrae, 40; hind foot, 17. Average of 4 specimens from Mount Shasta: Total length, 113; tail vertebrae, 41; hind foot, 16.2.

Remarks.—Four specimens of this new form of Gibbs shrewmole were collected by our party on Shasta—all in the Canadian zone. Three were caught in Mud Creek canyon near the mouth of Clear Creek by Walter K. Fisher and W. H. Osgood, and one was taken at Wagon Camp by Osgood. In May, 1894, my assistant, Clark P. Streater, obtained 3 specimens (the type and cotypes) at Carberry Ranch, on the south side of Pitt River, between Mounts Shasta and Lassen. Carberry Ranch is in the upper part of the Transition zone. The Canadian zone specimens from Shasta are not quite so large, but agree in other characters.

Scapanus californicus (Ayres). California Mole.

Vernon Bailey found a dead mole of this species, October 3, in the road between Wagon Camp and Sisson at an altitude of 4,500 feet. He reported mole ridges as common in places a little below Wagon Camp, and also in sandy soil in the Murray pine belt east of the mountain; W. H. Osgood saw mole ridges in Shasta Valley.

Myotis evotis (H. Allen.) Big-eared Bat.

At Sisson, September 5, R. T. Fisher obtained a specimen from a small boy, who caught it in a kitchen. The species doubtless occurs in Shasta Valley also.

***Myotis lucifugus longicus* (True).**

At Wagon Camp, July 17, Walter K. Fisher shot one of these bats. Small bats were abundant here, but kept so much in the forest that they were hard to shoot.

***Myotis californicus* (Aud. & Bach.). California Bat.**

A single specimen of this species, collected on Mount Shasta by C. H. Townsend, is recorded by Miller in *North American Fauna*, No. 13, page 71, October, 1897.

***Myotis yumanensis saturatus* Miller.**

Common among the alpine hemlocks at Squaw Creek Camp, where they were seen every night, darting in and out of the flickering light of the camp fire. Here I shot one the evening of August 3, and four the evening of August 9. Late in July and early in August small bats, probably the same species, were seen nearly every evening at the temporary camps on or near upper Mud Creek. The species is interesting as the only bat secured in the Hudsonian zone.

***Vespertilio fuscus* Beauvois. Large Brown Bat.**

Common at Wagon Camp, where Vernon Bailey shot one July 17, and I shot three the evening of July 28. Many more could have been killed if desired. In 1883 C. H. Townsend obtained it at Sheep Rock. The species is one of the commonest in the foothills and valleys, and is easily recognized on the wing by its large size and its character of flight.

[*Arctomys flaviventer* (Aud. & Bach.). Mountain Marmot.

It may be asserted with confidence that no marmots of any kind live on Shasta. Our collectors were at work on the mountain from July 15 until October without seeing a single individual. Moreover, when Vernon Bailey and I made our trip completely around the peak the latter part of July we kept near timberline all the way and made a special search for marmots, but were unable to find a trace of their presence.]

***Spermophilus douglasi* (Richardson). Oregon Ground Squirrel.**

Common at Sisson and in McCloud and Shasta valleys, whence it ranges up through the manzanita chaparral of the basal slopes nearly to Wagon Camp. At Sisson R. T. Fisher collected eight during the first half of September, and says of them: "One of the few really plentiful mammals at Sisson. Hardly an acre in the valley is free from their burrows. Under the barns and houses, in the fields, along the hot slopes east and west of the town, and even in the woods, one constantly sees them. At the time I write of, September 1-15, they seemed to be feeding chiefly on acorns and chinquapins—acorns in the valley, chinquapins on the western slopes. In behavior they were wild and sneaking; at all times difficult to approach. None appeared to have hibernated."

At Big Spring, in Shasta Valley, where they abound, W. H. Osgood saw several climb up on a beam and enter an opening in a granary.

Callospermophilus chrysodeirus Merriam. Golden-mantled Ground Squirrel.

One of the most abundant and conspicuous mammals of the mountain, where they were seen daily from the manzanita belt up to timberline, and where 52 specimens were collected. At Sisson they are rare, but 2,000 feet higher are fairly common, as they are also in Squaw Creek Valley at the south base of the mountain. In the fir forest they make their homes under logs or about the roots of trees, but in the neighborhood of timberline live in burrows under the rocks, often in slide rock, associated with small colonies of conies. At low altitudes they are usually unwary and may be easily killed with the 'auxiliary' barrel, but in the neighborhood of timberline they are so exceedingly shy it is difficult to approach within gunshot. At our camp among the alpine hemlocks on upper Squaw Creek they first kept at long range, but finding us harmless gradually overcame their fear, and finally, toward the end of the season, came to be one of the most persistent of camp robbers, stealing bread and other eatables. At the same time they never came freely and boldly as did their associates, the chipmunks, but always stole in silently and if possible kept out of sight.

This species goes into winter quarters much later than its relatives in the Rocky Mountain region. On Shasta it was seen daily near timberline until after the middle of September and a few were noticed on warm days as late as September 24, but all those secured during the latter part of the month were young of the year. Between Wagon Camp and Sisson they were seen as late as September 26.

Eutamias amoenus (Allen). Klamath Chipmunk.

Abundant in the chaparral of the lower slopes and thence up through the forest to timberline. Fifty-three specimens were obtained at various points on the mountain. At Wagon Camp they were common and were seen picking unripe serviceberries the latter part of July. At the south base of the mountain one was killed as low down as Warmcastle Soda Springs in Squaw Creek Valley. In the forest they live mostly about logs and stumps and are quite fearless, but along the upper edge of timber, where they live among the bare rocks, they are much more wary.

Eutamias senex (Allen). Allen Chipmunk.

Abundant in the Shasta fir belt and ranging down to Sisson and Warmcastle Soda Springs at the base of the mountain and up to the upper limit of continuous timber, though perhaps not to extreme timberline. Sixty-eight specimens were secured.

At Wagon Camp they were common and were usually associated with their small cousin, *E. amoenus*. They are more arboreal than the other

chipmunks and we often saw them in the trees 40 or 50 feet above the ground, moving about in the branches or chasing one another around the great trunks of the hemlocks and firs. At our camp in the alpine hemlocks on Squaw Creek they were the most abundant and most fearless of the diurnal mammals. Here they were constantly associated with the less abundant golden-mantled ground squirrels (*Callospermophilus chrysodeirus*), compared with which they are bolder, more active, more graceful, and more interesting.

In camp they made frequent visits to the mess box, which they clearly regarded as public property, approaching it boldly and without suspicion and showing no concern at our presence—in marked contrast to the golden-mantled ground squirrels, which approached silently, stealthily, and by a circuitous route, in constant fear of detection. If disturbed while stuffing their cheek pouches with bits of bread, pancake, or other eatables, each chipmunk usually seized a large piece in its mouth and scampered off, returning as soon as we withdrew. In fact, they made themselves perfectly at home in camp, and evidently ranked us with other harmless inhabitants of the forest. They climbed up the sides of our tent and over towels hung to dry on branches, as if such things had always been a part of their environment. It should be added, however, that the most familiar animals were always the young of the year, which probably had no recollection of the time before our arrival.

Along the upper border of the timber, where the ground is more open and is covered with gray rocks and pumice instead of the dark felt-ing of hemlock and fir needles and cones, the chipmunks are far more alert and wary.

After the middle of September the adults were rarely seen, and after the 20th the young came out only during the warmest part of the day.

At Sisson, R. T. Fisher found these chipmunks more abundant than any other mammal. They were common in the woods, in the chaparral, on the hillsides, and in the bottom of the valley. At the time of his visit—from the end of August to the middle of September—they were in the molt and very ragged.

Sciurus albolimbatus Allen. Sierra Pine Squirrel.

[=*S. californicus* Allen, preoccupied.]

Common in the Canadian zone forest of Shasta firs, and in the Transition forest of mixed pine and Douglas spruce. Among the Shasta firs they were seen on all sides of the mountain and came up as high as the lower edge of the alpine hemlocks. Among the pines and Douglas firs they were seen as low as Bear Butte, near Squaw Creek Valley, and were common at Sisson and thence northward along the base of the Scott Mountains. Like other pine squirrels they lay up stores of cones for winter use. At low elevations they rival the large gray tree squirrels in collecting the seeds of the huge cones of the sugar pines. At higher

elevations they seem to feed largely on the much smaller seeds of the Shasta firs, the cones of which they collect in large numbers. These cones are gathered in heaps at the bases of trees, where the squirrels live, and are also stored in decayed logs, where they are stuffed into all available openings. As 1898, the year of our visit, was an 'off year' for cones, we were forced, in order to obtain specimens, to take advantage of the stores made by these squirrels the previous year. In them we found innumerable cones, more or less perfect and with the seeds still untouched, of both *Abies shastensis* and *A. lowiana*.

Sciurus fessor Peale. Oregon Gray Squirrel: Large Tree Squirrel.

Fairly common in the pine forest covering the southern and western basal slopes of Shasta. At different times during the summer these large squirrels were seen in Squaw Creek Valley and between Sisson and Edgewood. On July 13 Vernon Bailey found them common near Bear Creek, between Fall River Valley and Shasta, where the sugar pines begin. They were then cutting off the scales and eating the green seeds of the half-grown cones of sugar pines.

Sciuropterus alpinus klamathensis Merriam. Klamath Flying Squirrel.

The only flying squirrel seen by our party was observed by me in August on a cedar stub near a small stream a couple of miles below Wagon Camp, but was not secured. There is therefore some uncertainty as to the species. At Sisson I was informed that a boy had a pair alive in a cage, but he left town with them before they could be examined.

Castor canadensis Kuhl. Beaver.

Probably not now living in the immediate vicinity of Shasta, although in 1883, according to C. H. Townsend, "a number of them occupied unmolested a dam, which they had constructed in a corner of a meadow belonging to Mr. J. H. Sisson." They were formerly common in Shasta River, where Walter K. Fisher was recently told a few were seen in the winter of 1898-99.

Aplodontia major Merriam. Aplodontia: Sewellel.

In making the circuit of Shasta the latter part of July, Vernon Bailey and I discovered a colony of aplodontias in some rank vegetation covering a springy place in Ash Creek Canyon, in the upper part of the Canadian zone. A little later W. K. and R. T. Fisher were sent there and obtained two specimens. About the same time they and W. H. Osgood caught eight in Mud Creek Canyon near the mouth of Clear Creek, at an altitude of nearly 7,000 feet.

Aplodontias live in wet or damp places usually overgrown with rank vegetation, and preferably in springy, sloping ground where some of their innumerable burrows and sunken runways are kept wet by the cold trickling water. As is well known, they cut various plants, commonly rank or woody kinds, which they gather and carry in bundles to their burrows, or to places near by, where they spread them out to dry.

In Ash Creek Canyon Walter Fisher found their cuttings to consist chiefly of ferns and willows—the latter carried from a long distance. In Mud Creek Canyon the cuttings consisted chiefly, according to W. H. Osgood, of thimble-berry bushes, mountain ash, and brake ferns—the latter predominating, and in one place forming a pile as big as a bushel basket. The animals commonly live in colonies, but Osgood concluded that in Mud Creek Canyon only one individual, or at most a pair, lived in one place, “though several may be distributed among the branches of a stream.”

Mus musculus Linn. House Mouse.

Abundant at Sisson, and running wild like the native species. R. T. Fisher reported them as constantly getting into his traps, particularly in the weeds and sedges in wet places along the banks of Cold Creek, where he caught a dozen or more.

Reithrodontomys klamathensis sp. nov.

Type from Big Spring (‘Mayten’), Shasta Valley, Calif. No. 9544, ♂ ad., U. S. Nat. Mus., Biological Survey Coll. Collected Sept. 18, 1898, by W. H. Osgood. Orig. No. 281.

Characters.—Size medium; ears and hind feet large; tail long, only slightly shorter than in *longicauda*; color grayish or brownish gray, decidedly paler than *longicauda*.

Color.—Summer pelage: Upperparts pale grayish brown, washed with buffy on sides; underparts white, tail bicolor, dusky above, whitish below.

Cranial characters.—Skull rather large; braincase and rostrum relatively broad; audital bullæ small. The skull as a whole agrees better with that of *megalotis* than with that of *longicauda*, particularly in the length of palate and breadth of braincase; but the rostrum is broader and the audital bullæ are smaller than in either.

Measurements.—Type: Total length, 149; tail vertebrae, 71; hind foot, 19. Average of 2 adults from type locality: Total length, 144; tail vertebrae, 66; hind foot, 18.5.

Remarks.—Both in color and cranial characters *Reithrodontomys klamathensis* resembles the pale grayish *R. megalotis* of the desert region of the southern part of the Great Basin much more closely than it does the dark brownish *R. longicauda* of California west of the Sierra.

This new harvest mouse is common in wet places in Shasta and Little Shasta valleys, where four specimens were obtained by W. H. Osgood and R. T. Fisher. They were caught in little runways in wet grass near tules. The species doubtless reached Shasta Valley by way of the open Klamath country. During our explorations in eastern Oregon in 1896, numerous specimens of the same species were caught by my assistants, E. A. Preble and Cleveland Allen, in the tule marshes bordering the streams connecting Malheur and Harney lakes.

Peromyscus gambeli (Baird). Common White-footed Mouse.

Common on all, or nearly all, parts of the mountain from Sisson up to and possibly a little above extreme timberline. One hundred specimens were collected.

In choosing their homes these mice are easily suited, for they seem equally contented among the dense vegetation in damp parts of the bottoms of canyons and among the bare lava rocks and punice soil of the driest timberline slopes. Some were caught also in the heather meadows bordering the little streams in the Hudsonian zone. At Sisson R. T. Fisher found them rather rare except in damp woods along Cold Creek, where he caught a number under roots and stumps close to the water.

Peromyscus boyli (Baird).

Exceedingly rare, or else of such peculiar habits that it escaped observation. Only a single specimen was obtained on Shasta. It was caught at the extreme upper limit of the Canadian zone (alt. 7,800 feet) on Squaw Creek, August 9, by Walter K. Fisher. Others were secured at Fall River Lake, in the Transition zone, southeast of the base of the mountain.

Peromyscus truei (Shf.). Big-eared Mouse.

Collected in Little Shasta Valley by Walter K. Fisher, who found it living among bushes of *Ceanothus cuneatus*.

Neotoma fuscipes Baird. Round-tail Wood Rat.

Not found on Shasta, but common in some of the low valleys at its base. Their characteristic stick houses were seen in the juniper forest at the southern end of Shasta Valley, in the chaparral near Gazelle, and in several places in the Scott Mountains (Bailey). In Little Shasta Valley one was collected September 19 (Osgood).

Neotoma cinerea Ord. Bushy-tail Wood Rat.

Rather scarce. Only four specimens were obtained—two in Mud Creek Canyon near the mouth of Clear Creek, and two high up on Squaw Creek (alt. 8,800 feet). Of those caught in Mud Creek Canyon, one was trapped at the end of an old log, the other at the entrance to an aplodontia burrow. Shasta abounds in the kinds of ledges and cliffs usually inhabited by this species, but, except at rare intervals, no traces of the animals were found.

Microtus californicus (Peale). California Vole.

Not obtained by us except in Shasta Valley, where six specimens were secured in September by W. H. Osgood and R. T. Fisher. Their runways were found in very wet places in the tules at Big Spring, in Shasta Valley, and along Little Shasta Creek. Walter K. Fisher secured specimens along Shasta River, northeast of Edgewood.

***Microtus montanus* (Peale).**

Not obtained on Shasta, but collected at Fall River Lake in August by W. K. Fisher. In August, 1883, seven specimens were collected in the grassy meadows at Sisson Tavern by C. H. Townsend.

***Microtus mordax* (Merriam). Mountain Vole.**

Common in suitable moist places throughout the Canadian and Hudsonian zones, particularly in the heather meadows a little below timberline, where, though chiefly nocturnal, they were sometimes seen in the daytime. Their burrows abound in the heather beds, especially along the overhanging banks of streams, and are so large that some of them were at first mistaken for those of *Microtus arviculoides*, a species which does not occur on Shasta. They were not found in the dry forest. Seventy-four specimens were collected, of which only six were obtained at Wagon Camp. Near Sisson Tavern R. T. Fisher caught fifteen along "the wet and bushy banks of a long ditch." They probably reach Sisson not from Shasta, but from Mount Eddy, in the Scott Mountains, near the foot of which Sisson Tavern is situated. Still, it is possible that the two colonies are connected along some of the few cold streams that traverse the Transition zone slopes of Shasta.

***Evotomys mazama* Merriam. Mountain Evotomys.**

Fairly common in moist places in the Shasta fir forests of the Canadian zone, where nineteen specimens were obtained. Ten were collected in Mud Creek Canyon near the mouth of Clear Creek (altitude 6,700 feet); seven along Squaw Creek from 6,700 up to 7,700 feet; one at the head of Panther Creek at 7,700 feet, and one at Wagon Camp at 5,700 feet. They were usually caught in traps set under logs in damp or wet places.

***Phenacomys orophilus* Merriam. Lemming-Mouse.**

Rare and local, judging from the results of our trapping. Only three specimens were obtained—all in the heather meadows along the upper part of Squaw Creek, where they were caught August 7, 10, and 12 by Walter K. Fisher.

***Thomomys monticola* Allen. Sierra Pocket Gopher.**

Abundant throughout the boreal slopes of the mountain, from the lower part of the Canadian zone to above timberline. In the dark forests of Shasta firs their mounds were seen wherever there was enough small vegetation to furnish food, and were commonest along the streams and about the edges of marshy places, where plant life is abundant and luxuriant. Above the line of continuous timber their mounds were noticed on many of the pumice slopes between the altitudes of 8,000 and 9,000 feet. Above the head of Squaw Creek a small colony was found at an altitude of 8,300 feet, and another between 8,900 and 9,000 feet. On the east side of Mud Creek Canyon they were seen at 8,800 feet, and on the west side at 8,900 feet. On our trip around the mountain near

timberline, the latter part of July, their mounds were found in almost every place where the soil was deep enough for the animals to work;



FIG. 31.—Winter earth plugs of pocket gopher.



FIG. 32.—Mound made by pocket gopher. (Photographed by W. H. Osgood.)

and on the north side they were abundant nearly up to timberline, both on the main peak and on Shastina.

At Wagon Camp, and thence eastward to Panther Creek, the whole country is honeycombed with their subterranean passages. While we were at Wagon Camp they were unmitigated pests, throwing up little mounds of fresh earth in our midst every day and keeping the ground disturbed the whole time, so that it was impossible to walk in any direction outside of the marsh without stirring up a cloud of dust. I shot several in camp in the daytime, as they poked their heads out of their burrows, pushing little loads of dirt before them. They throw out the earth so rapidly that it is difficult to observe the process accurately. One *appeared* to empty it from his pouches, but I shot him in the act and found his pouches free from dirt and full of cut pieces of roots.

On the higher slopes the winter earth plugs—the cylinders of earth mixed with heather which in winter are pushed up into the snow from the underground passages—remain on the ground all summer, a striking evidence of the absence of rains, for a single hard shower would disintegrate and wash them away. They usually take the form of irregular serpentine ridges; but on Squaw Creek one was found which formed a complete oval ring with radiating cylinders. A photograph of this one, taken August 1, 1898, is here reproduced. (See fig. 31.)

Thomomys monticola pinetorum subsp. nov. Pine-woods Gopher.

Type from Sisson, Siskiyou County, Calif. No. 95152, ♂ ad., U. S. Nat. Mus., Biological Survey Coll. Collected Sept. 4, 1898, by R. T. Fisher. Orig. No. 173.

Characters.—Similar in general to *T. monticola*, but slightly smaller; skull shorter and broader; color very much paler.

Color.—Upperparts pale fulvous, almost orange fulvous (in striking contrast to the much darker colors of *monticola* and *mazama*); nose dusky; sides of head in one pelage plumbeous or slaty faintly washed with buffy; in other pelage strongly washed with ochraceous.

Cranial characters.—Skull, contrasted with that of *monticola*, short and broad, with zygomata much more widely spreading.

Measurements.—Type: Total length, 210; tail vertebrae, 76; hind foot, 28.

Remarks.—Common at Sisson and thence up to Wagon Camp, grading gradually into *T. monticola*.

Dipodomys californicus Merriam. Kangaroo Rat.

Common in the manzanita chaparral on the south side of Shasta from Squaw Creek Valley, near McCloud Mill, up along the road to Wagon Camp, as far at least as an altitude of 4,800 feet, where their unmistakable tracks abounded in the dusty soil. In Shasta Valley they are exceedingly abundant and destructive to grain, according to complaints of the ranchmen. Here W. H. Osgood found their little trails winding about through the sage brush in all directions, and saw fresh tracks in the road every morning.

Perognathus mollipilosus Cones. Mountain Pocket-Mouse.

Common in the manzanita chaparral, a little below Wagon Camp, where four were caught in July by R. T. Fisher. But the most extraordinary locality at which the species was found—and for that matter the most remarkable and abnormal place in which any species of the family has ever been found—is a subalpine pumice basin near timberline at the head of Panther Creek, where Walter K. Fisher discovered it and caught two the night of July 18. Later, six more were secured at the same place.

In Shasta Valley Vernon Bailey and W. H. Osgood found abundant signs of some species of *Perognathus*, but did not obtain specimens. The species is probably *P. parvus*, which is common in the adjacent Klamath Basin.

Erethizon epixanthus Brandt. Poreupine.

Apparently common, and yet not a specimen was obtained. Their characteristic gnawings on the trunks of small trees were seen at many points around the mountain, usually in the Hudsonian or upper part of the Canadian zone. They were common among the dwarf timberline white-bark pines on the north sides of both Shasta and Shastina; and in a small forest of young Shasta firs between Mud Creek Canyon and Cold Creek. Near timberline we several times found small trees whose tops had been gnawed in winter when they protruded above the snow. In a single instance fresh tracks were seen in the trail between Wagon Camp and Squaw Creek Camp (by Vernon Bailey). And on August 4 our favorite mule came into camp with porcupine quills in his nose. C. H. Townsend found porcupines in surprising abundance in Lassen County, south of Shasta, in 1883 and 1884, and gives an interesting account of their habits.

Zapus trinotatus alleni Elliot. Sierra Jerboa.

Fairly common in damp places on and near the mountain. Twenty specimens were collected—fifteen in the Canadian zone in Mud Creek Canyon near the mouth of Clear Creek (alt. 6,700 feet), two near the upper part of Mud Creek (alt. 7,900 feet), and three at Wagon Camp.

One of the most attractive spots near Wagon Camp is a grove of ponderosa pines in which the ground is carpeted with strawberries and scarlet painted cups, mixed with ferns and scattered clumps of serviceberries. The soil, while not wet, receives enough moisture from the little streams that sink into the ground a few rods above to enable these plants to grow in such profusion that they form a continuous meadow—'Castilleja meadow' we called it, from the abundance of painted cups. Here the jerboas abound. We saw several in the daytime, leaping about like frogs in the dense vegetation, and caught one or two in our hands.

In Mud Creek Canyon, W. H. Osgood informs me, they were also frequently seen in the daytime, in wet places under the white hellebore (*Veratrum californicum*).

Zapus pacificus Merriam. Valley Jerboa.

Only two specimens of this little-known species were secured and one of these was destroyed in the trap. They were caught in thickets on the banks of Little Shasta Creek September 20 by R. T. Fisher.

Ochotona schisticeps (Merriam). Cony; Pika.

Relatively rare and confined to small and widely separated colonies. During our circuit of the mountain, made near timberline the latter part of July, we saw what we took to be signs of conies among rocks east of Mud Creek Canyon, but finding no more believed we had been mistaken, until the evening of July 24, when we camped on some rivulets of snow water on the north side of Shastina. Here we found a small scattered colony reaching up in the slide rock from about 8,000 to nearly 10,000 feet, and a specimen was secured by Vernon Bailey. The next day we found signs in Cascade Gulch a mile or two northwest of Horse Camp. Later, when camped in the alpine hemlocks on the small west branches of Squaw Creek, we found a colony in the slide rock close by. Conies were afterwards found on both sides of Red Butte and on the east side of Gray Butte, and Osgood heard one near the head of Mud Creek Canyon. In all, 14 specimens were collected.

This species differs in habits and voice from those of the Rocky Mountains; it is less noisy and less often heard in the middle of the day, for which reason it is more apt to escape detection, and its common note, instead of the usual 'bleat,' is a loud shrill *eh' eh'*, or *eh' eh' eh'*. It seems to be most active in the late afternoon and on moonlight evenings, and its voice is heard at all hours of the night.

On most mountains where conies live, their well known accumulations of plants of various kinds, cut and piled on the rocks to dry, are conspicuous objects. But on Shasta, where I often saw the animals carrying freshly cut plants to their dens in the slide rock, I failed to find a single 'haystack.' In one place a few fresh stems of *Polygonum neiberryi*, with its large broad leaves, were seen, and in another a large accumulation of old brown leaves of the same species mixed with a larger quantity of *Phyllodoce empetrifomis*—apparently left over from the previous year. But the only real 'haystack' found on the mountain by



FIG. 33.—Rock cony (*Ochotona schisticeps*)—Photographed by F. Stephens.

any of the party was discovered on the east side of Gray Butte September 25 by Vernon Bailey. It contained *Epilobium spicatum*, *Holodiscus discolor*, *Monardella odoratissima*, *Hieracium horridum*, *Ceanothus velutinus*, and two species of grass. The bulk of the material was *Epilobium* and *Monardella*.

On the west slope of Goose Nest Mountain, just east of Little Shasta Valley, Walter K. Fisher found conies common in an area of slide rock which extends in a practically unbroken stretch from the top to the bottom of the mountain. I have not seen the specimens.

Lepus nuttalli Bachman. Sagebrush Cottontail.

Several seen and two secured by W. H. Osgood in the sagebrush in Shasta and Little Shasta valleys, near the north base of the mountain.

Lepus klamathensis sp. nov. Klamath Rabbit.

Type from Fort Klamath, Oregon. No. 92248, ♀ ad., U. S. Nat. Mus., Biological Survey Coll. Collected Jan. 25, 1898, by B. L. Cunningham. Orig. No. 86.

Characters.—Similar to *L. columbiensis* Rhoads, but color fulvous instead of yellowish, with a distinct white stripe on hind foot; skull characters distinctive.

Color.—*Summer pelage*: Upperparts grizzled fulvous and black, the fulvous rather pale and dull, but not at all yellowish as in *columbiensis*; head, face, and pectoral collar dull fulvous; chin, throat, and belly white; a white stripe, sometimes irregular, extending along full length of upper surface of hind foot, on inner side, and usually including toes. *Winter pelage*: Either snow white all over, or like summer pelage but with black hairs much more plentiful.

Cranial characters.—Skull similar to that of *columbiensis* but somewhat smaller and narrower; interorbital breadth at anterior notch less; bulke decidedly smaller (smallest of the *americanus-bairdi-washingtoni* group); outer face of jugal very deeply grooved anteriorly, and with upper ridge reaching anteriorly beyond end of groove.

Measurements.—*Type*: Total length, 432; tail vertebrae, 28; hind foot, 127. Average of 3 specimens from type locality: Total length, 410; tail vertebrae, 39; hind foot, 126.

Remarks.—*Lepus klamathensis* is a member of the *americanus-bairdi-washingtoni* group. In color it is intermediate between the yellowish *columbiensis* and the dark fulvous *washingtoni*. In cranial characters it agrees best with *columbiensis*, particularly in the great length of the postorbital processes, but in the small bulke and peculiar form of the jugal it differs from all known members of the group.

This rabbit is common in the alder thickets in marshy places and along streams near Fort Klamath, Oregon, from which place the late Major Chas. E. Bendire sent me several specimens in the winter of 1883-84; and from which we have recently obtained additional specimens from B. L. Cunningham.

A curious feature about *Lepus klamathensis* is the fact that it sometimes does, and sometimes does not, turn white in winter. In the Biological Survey collection we have brown specimens killed late in January and white ones killed early in April.

This species was not obtained on Shasta, but rabbit dung, supposed to belong to it, was found in many places, particularly under the dwarf *Pinus albicaulis* on the timberline ridges. Rabbit signs and tracks were seen also in the manzanita chaparral, but as no specimens were secured the species is a matter of conjecture.

Lepus californicus Gray. California Jack Rabbit.

Occurs in Shasta Valley at the north base of the mountain. Several were seen and one was killed near Edgewood September 30 by W. H. Osgood.

Odocoileus columbianus (Richardson). Columbia Black-tail Deer.

Abundant on Shasta and throughout the surrounding region. Even at Wagon Camp, which probably is visited by more hunting parties than any other part of the mountain, deer were numerous, and their well-beaten trails were in constant use during our stay. At first the animals were commonest in the lower part of the Shasta fir forest, where for a long time they were not driven away even by the frequent shooting of our bird collectors. When we had been at Wagon Camp a week they were still common within an eighth of a mile. Later, however, they became less numerous in the open forest and more abundant in the dense chaparral of manzanita and buck-brush a little lower down. They were common also on Red Butte, and along all of the streams and canyons on the west, south, and southeast sides of the mountain. On the west side, where water is scarce, numbers used to visit the pools in Cascade Guleh, northwest of Horse Camp. In Mud Creek Canyon their trails were so abundant as to form almost a mesh-work. When we visited this canyon first, July 22, Vernon Bailey saw eight deer; and several of us, resting on the west rim of the canyon, watched a doe and fawn on one of the trails on the opposite side. They were so plentiful in a canyon about a mile east of Squaw Creek that I named the place Deer Canyon. Several times during the season does with spotted fawns were seen in the Shasta fir forest. A yearling 'spike-buck' killed on Squaw Creek by Vernon Bailey August 7 was in the velvet, and his worn summer coat was scant and faded. Another 'spike-buck,' killed in the mountains west of Scott Valley September 15, was in the fresh gray winter coat, with only a few red hairs of the summer coat left.

In September the old bucks, which had not been observed earlier, climbed the mountain and began to appear on the higher ridges, where they travel extensively in the timberline tongues of dwarf white-bark pines. On September 18 I followed the tracks of two large bucks along the upper part of Panther Creek and found where they had bedded

close together under a low Shasta fir on a steep slope, from which they could overlook the country below.

C. H. Townsend, in his notes on the mammals of northern California, gives an interesting account of this deer.

Odocoileus hemionus (Rafinesque). Mule Deer.

In the region east of Shasta, where the Columbia black-tail is the prevailing species, C. H. Townsend occasionally found the mule deer. "But in Lassen County, a hundred miles farther south, the reverse was found to be the case," and he saw nothing of the Columbia black-tail. This was in 1883 and 1884. The mule deer was not observed on Shasta by our party, although the tracks of an immense buck, seen by me early in August on the rim of Mud Creek Canyon, may have been made by it. Sherman Powell, in a recent article in *Forest and Stream* (April 27, 1899), states that mule deer are plentiful a little east of Shasta "on and around Glass Mountain, and also on the northeast slopes of Black Fox Mountain."

Cervus occidentalis Ham. Smith. Elk.

One of our party, R. T. Fisher, was informed by George B. Mitchell, county surveyor of Siskiyou County, that elk were shot in the neighborhood of Sisson as late as the early seventies. They were formerly abundant on and about Shasta, particularly in Squaw Creek Valley and Elk Flat, and used to range along the Scott Mountains, and thence westerly to the coast, where a few still exist.

Antilocapra americana Ord. Prong-horn Antelope.

Antelope, we were told, still inhabit the open pine forest east and northeast of Shasta. Formerly they were common in Shasta Valley and ranged west into the foothills of the Scott and Siskiyou mountains.

The following information regarding their distribution was obtained by Walter K. Fisher: In winter they ranged in the country between the Edgewood divide and the foothills of the Siskiyou mountains north of Hornbrook, extending into the low valleys west of Shasta River. They were most plentiful in the region between Little Shasta and Gazelle. Mr. Masgrave, one of the first settlers in Little Shasta Valley, is authority for the statement that formerly they frequently herded with his cattle. In Scarface Valley, west of Gazelle, he once saw a large herd which contained not less than two thousand animals.

In summer the antelope ranged extensively through Goose Nest Mountain and wooded valleys in Butte Creek region, as well as in Shasta Valley, Big Valley, Fall River Valley, and about Tule Lake, Klamath Falls, and Goose Lake. At present only a small herd remains. They stay in the remoter valleys east of the mountains and rarely come to Shasta Valley. In the summer of 1898 three were seen on the road between Little Shasta post-office and Butte Creek.

Ovis canadensis Shaw. Bighorn; Mountain Sheep.

The bighorn no longer inhabits Shasta, but its bleaching bones still remain. In early days, and as late as the seventies, many were killed here by J. H. Sisson, of Sisson Tavern. Sheep Rock, at the northeast base of the mountain, was one of their favorite and latest resorts, but probably was not used during the breeding season. In 1868 George B. Mitchell saw a band of twenty near the head of Mud Creek Canyon. In 1883 C. H. Townsend found numbers of their horns and bones scattered about everywhere on Sheep Rock, and saw the complete skeleton of a bighorn at the foot of Mud Creek glacier, high up on Shasta. An old skull was found on Red Butte by Vernon Bailey during our stay.

Canis lestes Merriam. Mountain Coyote.

Common high up on the mountain, frequenting the punice slopes above timberline, where their tracks were often seen. Coyotes were especially common east of Mud Creek Canyon, where R. T. Fisher saw two early in August. As no specimens were secured, the species is uncertain, but since *C. lestes* is the animal inhabiting the Sierra farther south and (in a somewhat less typical form) the Klamath country farther north, it is assumed to be the mountain coyote of Shasta.

Canis ochropus Esch. Valley Coyote.

Common in Shasta valley and also at Sisson. R. T. Fisher heard them nearly every night during his stay at Sisson, from the end of August until the middle of September; and about the end of September Vernon Bailey and W. H. Osgood heard them howl at night in the south end of Shasta valley. A little farther north, in the flat valley near Montague, I saw a highly colored one at close quarters in the day time August 31. In July, 1899, Walter K. Fisher secured one in Shasta Valley.

Vulpes macrourus Baird. Mountain Red Fox.

Common on the upper slopes above timberline, where fresh tracks were seen nearly every day; but the animals were very wary and refused to enter our traps.

Urocyon californicus townsendi subsp. nov. Townsend Gray Fox.

Type from Baird, Shasta County, Calif. No. 14130, U. S. Nat. Museum. Collected November 11, 1893, by C. H. Townsend. Orig. No. 49.

Characters.—Similar to *U. californicus* Mearns, but ears decidedly smaller; fulvous tints everywhere darker and richer; rostrum broader; zygomata broader anteriorly; carnassial teeth above and below, larger and thicker. The color of the upperparts and tail is grizzled gray and black, as in *californicus*, but the fulvous of the ears, legs, and underparts is very much darker and somewhat more extensive. The sides of neck and posterior part of throat are rufous, in sharp contrast with the restricted white of the chin and anterior part of throat; the ears are

dark grizzled fulvous; the white stripe on the hind foot of *californicus* has disappeared and is represented by a pale streak.

Remarks.—Gray foxes are abundant in the Transition zone about the base of Shasta, and although no specimens were secured by our party a number were obtained by C. H. Townsend in 1883 along the McCloud River.

Felis oregonensis Rafinesque. Oregon Puma; Mountain Lion.

Rather rare, but formerly common on Shasta. In July Bailey saw fresh tracks among the Shasta firs a little below Red Butte. C. H. Townsend obtained seven specimens in Shasta County in 1883 and 1884, several of which were killed near the fish hatchery on the McCloud. He states: "It is practically impossible to raise colts in the Shasta County hills on account of these pests. They destroy many hogs and young cattle also, but do not present so serious an impediment to the keeping of these animals as in the case of horses. Mr. J. B. Campbell, who trapped two panthers for me in 1883, told me that he had actually never seen more than two or three of the numerous colts born on his stock range, as they had been killed and devoured by panthers soon after birth."

Lynx fasciatus pallescens subsp. nov. Wild-cat.

Type from south base of Mount Adams, near Trout Lake, Washington. No. 76585, ♂ ad., U. S. Nat. Mus., Biological Survey Coll. Collected January 10, 1895, by D. N. Kaegi. Orig. No. 23.

Characters.—Similar to *L. fasciatus*, but slightly smaller and everywhere very much paler, particularly the head and face; basal black ear patch (in winter pelage) indistinct or absent; gray ear patch larger; general color hoary gray, contrasted with the dark rich rufous of *fasciatus*. Skull like that of *fasciatus*, but slightly smaller; carnassial teeth and second upper molar less swollen.

Remarks.—Specimens from the region about Shasta (Klamath country on the north and Pitt and McCloud rivers on the south) differ slightly from Trout Lake specimens; they show less tendency to spotting and have slightly larger carnassial teeth and audital bullæ.

This wild-cat is fairly common in the chaparral of the basal slopes of Shasta. One was seen a little below Wagon Camp, and tracks were several times noted by Vernon Bailey in the trail a little above Wagon Camp. Tracks were seen also in Shasta Valley by W. H. Osgood. In 1883-84 C. H. Townsend trapped many wild-cats along McCloud River and the lower part of Squaw Creek, where they were "apparently as numerous as [gray] foxes, and as easily secured." Most of these belong to the present species, but one belongs to the following:

Lynx californicus (Mearns). California Wild-cat.

A specimen which I provisionally refer to this species was obtained by C. H. Townsend at Baird, on McCloud River, in 1883. It is a much smaller animal than *L. fasciatus pallescens* and has conspicuously smaller teeth.

Gulo luscus (Linn.). Wolverine.

We have no positive record of the wolverine from Shasta, but it is known to occur on both the Cascades and the Sierra, and one was killed near Carberry Ranch, between Mounts Shasta and Lassen, about the year 1893 (reported by C. P. Streater).

Wolverines are notorious wanderers and it is most probable that they occur on Shasta at intervals, even if they do not permanently live there—which is by no means certain.

Taxidea taxus (Schreber). Badger.

Very rare on Shasta. In the trail between Wagon Camp and Squaw Creek Camp fresh tracks were seen August 4, by Vernon Bailey, and in Shasta Valley, at the north base of the mountain, badger holes were reported by W. H. Osgood, who also found a dead badger in the road a few miles east of McCloud Sawmill.

Mephitis occidentalis Baird. Large Skunk.

Common in the low country around Shasta. On 'Horse Trail,' leading up the mountain from Sisson, Bailey saw their tracks as high as an altitude of 6,500 feet. At Sisson they are particularly abundant in the wet meadows and thickets, where in September R. T. Fisher caught two along Cold Creek. In Shasta Valley they are also common and several were caught by W. H. Osgood and R. T. Fisher.

Spilogale latifrons Merriam. Little Spotted Skunk.

Not obtained by us, but known to occur in the general neighborhood of Shasta, both north and south of the mountain. In March, 1884, C. H. Townsend caught one on McCloud River, about midway between the mouth of this stream and Mount Shasta.



FIG. 34.—Mink. (Drawn by Ernest S. Thompson.)

Lutreola vison energumenos (Bangs). Pacific Mink.

Common along the streams at Sisson, where R. T. Fisher caught two, one on Cold Creek, the other on the upper Sacramento River.

***Mustela caurina* Merriam. Pacific Marten.**

Common in parts of the dense forests of Shasta, particularly on the east side, where many are caught every winter by trappers. We did not succeed in obtaining a specimen, although a line of 'meat traps' was kept out fully a month. Still, fresh tracks were seen in the mud along Squaw Creek a short distance below camp by Vernon Bailey.



FIG. 35.—Marten. (Drawn by Ernest S. Thompson.)

***Mustela pennanti* Erxleben. Fisher.**

Said to occur in the dense forest on the east side of Shasta, whence skins are brought to Sisson for sale nearly every winter. C. H. Townsend obtained two on McCloud River, about halfway between the mouth of the river and Mount Shasta, in February, 1884.

***Lutra hudsonica* Lacépède. Otter.**

Occurs along the upper Sacramento and McCloud rivers; not noted by our party.

***Putorius arizonensis* Mearns. Mountain Weasel.**

Apparently not common. Early in August three were caught in Mud Creek Canyon, near the mouth of Clear Creek, in traps set in *Aplodontia* runways. It is quite possible that another species, *P. xanthogenys oregonus*, inhabits the low country about the base of the mountain.

***Bassariscus astutus raptor* (Baird). Cacomistle; Ring-tail Cat.**

Not observed by us, but doubtless occurs about the basal slopes of Shasta, as it has been captured both north and south of the mountain.

In February, 1884, C. H. Townsend caught one on McCloud River, about halfway between the mouth of the river and Mount Shasta; he also mentions a Pitt River miner who had a pair alive; and C. P. Streater reports it from old Fort Crook and Carberry Ranch. In September, 1896, one of our collectors, E. A. Preble, caught one in upper Rogue River Valley, near Prospect, Oregon.

***Procyon psora pacifica* subsp. nov. Pacific Raccoon.**

Type from Kechelus Lake, Cascade Mountains, Washington. No. 93137, ad., U. S. Nat. Mus., Biological Survey Coll. Collected Jan. 15, 1898, by C. Hansen.

Characters.—Coloration dark; ground color dark gray instead of buffy; tail rings continuous (not interrupted along median line below); last premolar, first molar, and audital bullæ larger than in *psora*.

Color.—Upperparts dark gray everywhere profusely mixed with and obscured by black hairs; underparts sooty-plumbeous sparingly sprinkled with long buffy whitish hairs; sooty collar under throat continuous and much darker than in *psora*: black rings on tail continuous; pale rings, particularly the last one, obscured above by black hairs.

Measurements.—Type (from dry skin): Total length, 940; tail vertebrae, 310; hind foot, 115.

Remarks.—This new raccoon is most typical in the northwest coast region, particularly about Puget Sound and along the basal slopes of the northern Cascades. Specimens from Pitt River and Little Shasta Valley are much nearer *pacifica* than *psora*.

Raccoons do not occur on the higher slopes of Shasta, but are common about its base. In Little Shasta Valley W. H. Osgood and R. T. Fisher found them particularly abundant about the middle of September, and caught several in traps set under prune trees. The animals were causing much annoyance to the fruit-raisers by nightly visits to the orchards.

***Ursus americanus* Pallas. Black Bear.**

Abundant. When we reached Shasta the middle of July, black bears were exceedingly common throughout the Shasta fir forest. On July 17, in going from Wagon Camp to timberline, we saw fresh tracks of a dozen along Panther Creek, and on the way down, three hours later, saw where four had crossed our trail after we had gone up. Their well-worn trails abounded along Panther Creek and were traversed daily until about the end of July, when, after our collectors had been shooting for nearly two weeks, the bears became alarmed and moved down into the manzanita chaparral below the Shasta firs, where they remained the rest of the season.

***Ursus horribilis* Ord. Grizzly or Grisly Bear.**

Formerly abundant in the Shasta region; now exceedingly rare or absent. W. H. Osgood was told when in Shasta Valley that a few years ago a huge grizzly known as 'Old Clubfoot,' which had been shot at repeatedly, was killed near Goose Nest Mountain, just north of Shasta.

BIRDS OF SHASTA AND VICINITY.

(All dates except where the year is stated are for the year 1898.)

1. *Podilymbus podiceps*. Pied-billed Grebe; Hell Diver.

Several seen in the pond at Big Spring, in Shasta Valley, September 17, by W. H. Osgood. C. H. Townsend obtained it "on ponds near the base of Mount Shasta in summer" in 1883 or 1884.

2. *Anas boschas*. Mallard.

W. H. Osgood shot a mallard in Lower Squaw Creek, near Warm-castle Soda Springs, September 13, and found the species common at Big Spring, in Shasta Valley, September 17. In 1883 C. H. Townsend "found mallards August 1, at the base of Mount Shasta, in certain wet meadows where, in all probability, they had nests."

3. *Querquedula cyanoptera*. Cinnamon Teal.

The commonest duck on the small ponds and streams in Shasta Valley September 17-20 (Osgood).

4. *Spatula clypeata*. Shoveller.

Several seen in Shasta Valley September 17 by W. H. Osgood.

5. *Dafila acuta*. Pintail.

A flock of six seen in Shasta Valley September 18 by W. H. Osgood.

6. *Branta canadensis*. Canada Goose.

Three seen at Big Spring, in Shasta Valley, September 18 (Osgood).

7. *Ardea herodias*. Great Blue Heron.

Seen at Sisson July 13 by W. H. Osgood, and repeatedly observed during the first half of September by R. T. Fisher; several seen in Shasta Valley September 17-20 by W. H. Osgood; common along Shasta River (W. K. Fisher).

8. *Porzana carolina*. Sora Rail.

One seen in Shasta Valley September 18 by W. H. Osgood.

9. *Fulica americana*. Coot; Mud Hen.

One seen among the numerous ducks in the pond at Big Spring, in Shasta Valley, September 18 (Osgood).

10. *Gallinago delicata*. Wilson Snipe.

In Shasta Valley one was seen by W. H. Osgood September 18; and I saw one at Edgewood August 2, 1899. On a small tributary of McCloud River, flowing from the east base of Mount Shasta, one was shot by C. H. Townsend July 25, 1883.

11. *Ereunetes occidentalis* (?) Western Sandpiper.

A flock of small sandpipers supposed to be this species was seen by W. H. Osgood in Shasta Valley September 19.

12. *Totanus flavipes*. Yellow-legs.

A wader believed to be this species was heard in Shasta Valley September 19 by R. T. Fisher.

13. *Helodromas solitarius cinnamomeus*. Western Solitary Sandpiper.

Not observed by us, but in 1883 a male was seen at Sisson on August 3 by C. H. Townsend.

14. *Actitis macularia*. Spotted Sandpiper.

C. H. Townsend secured a spotted sandpiper at Sisson August 2, 1883. Late in July, 1899, Walter K. Fisher found it rather common on Shasta River.

15. *Ægialitis vocifera*. Killdeer.

Common at Sisson, where from July to early September a small flock was always crying and feeding in the meadows between the town and Sisson Tavern. Abundant and noisy in Shasta Valley September 17-20 (W. H. Osgood).

16. *Oreortyx pictus plumiferus*. Plumed Mountain Quail.

Fairly common, but not often seen, in the Shasta fir belt and the manzanita chaparral along its lower edge. Two or three broods were found near Wagon Camp the latter part of July, when the young were hardly a third grown. Several were seen and killed high up on Mud Creek Canyon August 8 by R. T. Fisher and W. H. Osgood, who also saw several flocks in Shasta Valley September 17-20. At Sisson, the first half of September, R. T. Fisher found many small flocks in the dry woods and chaparral west of the village.

17. *Lophortyx californicus vallicola*. California Valley Quail.

Not found on the mountain, but common in Little Shasta Valley, where W. H. Osgood secured a specimen September 19. In August, 1883, C. H. Townsend saw them "in considerable numbers at the base of Mount Shasta," near Sisson.

18. *Dendragapus obscurus fuliginosus*. Sooty Grouse.

Fairly common in the Shasta fir forest, and less so at higher altitudes. At Wagon Camp, during the last half of July, we often saw a hen grouse with half a dozen young; and in a rocky place among the alpine hemlocks near Squaw Creek, in September, we several times ran across a small flock, all full grown, feeding among patches of mountain chinquapin and the dwarf mountain manzanita (*Arctostaphylos nevadensis*). Berries of the latter formed the principal contents of the crop of one killed by Vernon Bailey August 24. Mixed with these berries were seed capsules of *Pentstemon gravilentus* and a few large

ants. Usually the grouse were found singly or in bunches of two or three in the forest. When disturbed they generally flew up into the tall Shasta firs, where, instead of remaining motionless like many grouse, they walked about among the branches, stepping deliberately from limb to limb, but keeping on the opposite side from the enemy, so that it was almost impossible to see them.

The old males were sometimes found high up on the lava ridges among dwarf *Pinus albicantis*, 1,000 feet or more above the continuous forest. When flushed they usually spread their wings and soared down the steep mountain side until lost from sight in the forest below. The 'hooting' or 'booming' of the old males, so often heard in the northern Cascades, was not heard by any of our party on Shasta.

19. *Zenaidura macroura*. Mourning Dove.

Fairly common at Sisson. In Shasta Valley W. H. Osgood found them abundant September 17-20.

[The band-tail pigeon (*Columba fasciata*) was not observed in the region by my party, but in the fall and winter of 1883 C. H. Townsend found it abundant in the foothills of the lower McCloud River, "gathering in the pine trees on the higher ridges in immense flocks."]

20. *Cathartes aura*. Turkey Vulture.

One or two seen at Wagon Camp and between Wagon Camp and Sisson in July; one seen by Walter K. Fisher at timberline, east of Mud Creek Canyon, about the end of July. At Sisson and in Shasta Valley they were more common.

21. *Circus hudsonius*. Marsh Hawk.

Seen at Sisson the middle of July (F. A. M.) and end of August (C. H. M.). Seen in Shasta Valley September 17-20 (W. H. Osgood).

22. *Accipiter velox*. Sharp-shinned Hawk.

Rather rare. One shot near Squaw Creek Camp August 10 by Vernon Bailey; one seen on Mud Creek in August, and several in Shasta Valley by W. H. Osgood September 17-20. C. H. Townsend shot one at timberline on Shasta September 7, 1883.

23. *Accipiter cooperi*. Cooper Hawk.

Rather rare. One killed above timberline (alt. 9,400 feet) above the head of Squaw Creek August 21 by R. T. Fisher. In September 1883, C. H. Townsend shot one near timberline on Shasta.

24. *Accipiter atricapillus striatulus*. Western Goshawk.

One visited our camp at Squaw Creek August 28. It was shot at but not secured. July 28, 1883, C. H. Townsend shot two young goshawks near timberline on Shasta.

25. *Buteo borealis calurus*. Western Red-tail.

Rather common. Seen from time to time at Wagon Camp in July and early August, frequently at Squaw Creek Camp in August and September, and several times above timberline. One was seen flying over the summit of Shasta July 31 by W. H. Osgood and R. T. Fisher. Common during fall migration in Shasta Valley, where Osgood saw many September 17-20, and I saw several September 29—chiefly about the narrow meadows bordering Shasta River. At Sisson Miss Florence A. Merriam saw them September 3.



FIG. 36.—Red-tail (*Buteo borealis*). Drawn by J. L. Ridgway.

26. *Buteo swainsoni*. Swainson Hawk.

Rare. July 28 I saw a nearly black Swainson hawk near an abandoned sawmill (alt. 4,800 feet) on the road from Wagon Camp to McCloud Mill. In July, 1899, Walter K. Fisher saw one in Shasta Valley.

27. *Aquila chrysaëtos*. Golden Eagle.

Rather rare, but seen from time to time flying over the mountain, usually at high altitudes. C. H. Townsend shot one near Sheep Rock, at the north base of Shasta, August 21, 1883.

28. *Haliaeetus leucocephalus*. Bald Eagle.

In speaking of the bald eagle, C. H. Townsend states that when he had climbed to the extreme peak of Shasta (alt. 14,440 feet), on July 27,

1883. "an eagle came up through the fog that had gathered immediately below us and shared with us our rocky pinnacle above the clouds."

29. *Falco mexicanus*. Prairie Falcon.

Several seen and one shot in the south end of Shasta Valley, at the north base of the mountain, September 30, by W. H. Osgood, who thinks it probable that they breed on the cliffs at Sheep Rock.

30. *Falco columbarius sackleyi*. Black Merlin.

At Wagon Camp, August 8, John H. Sage and I saw a small dark falcon, supposed to be Sackley's merlin, fly into a Shasta fir, but we were unable to shoot it.

31. *Falco sparverius*. Sparrow Hawk.

Common at timberline throughout the summer. Usually seen in the heather patches and among the white-bark pines, where they were



FIG. 37.—Sparrow Hawk (*Falco sparverius*).—Drawn by J. L. Ridgway.

feeding on grasshoppers. Several were killed near timberline, east of Mud Creek Canyon, the latter part of July and early August, and one was recorded as high as 13,000 feet by Walter K. Fisher. On the west side of Mud Creek Canyon two were killed August 11 at an altitude of 10,000 feet by Vernon Bailey. Their stomachs were distended with

grasshoppers. At the north base of the mountain one was seen by me on the narrow meadows bordering Shasta River in Shasta Valley September 29, and several were observed farther north in the valley September 17-20 by W. H. Osgood and R. T. Fisher. At Sisson they were seen July 15 by Miss Florence A. Merriam.

32. *Bubo virginianus*. Great Horned Owl.

Rare. Feathers were found at two or three places on the mountain, and at Sisson birds were heard hooting.

33. *Speotyto cunicularia hypogæa*. Burrowing Owl.

Not observed by us, but reported by C. H. Townsend as common "on the sage-covered districts north of Mount Shasta," about 15 miles from the mountain.

34. *Glaucidium gnoma californicum*. California Pigmy Owl.

C. H. Townsend obtained two specimens of the pigmy owl August 7, 1883, at the big spring, a mile or two north of Sisson Meadows.

35. *Megascops asio bendirei* (?). California Screech Owl.

A screech owl was heard at Wagon Camp at different times during the season, particularly the latter part of September, but as no specimen was secured there is some doubt as to the subspecies.

36. *Coccyzus americanus occidentalis*. California Cuckoo.

One shot and others seen in July, 1899, by Walter K. Fisher, among the alders and birches on Shasta River east of Edgewood.

37. *Ceryle alcyon*. Kingfisher.

A common resident in the neighborhood of Sisson, where it was seen repeatedly along Cold Creek, at the fish hatchery, and along the upper Sacramento; seen also along Shasta River north of Sisson.

38. *Dryobates villosus hyloscopus*. Cabanis Hairy Woodpecker.

Rather rare. Two or three were seen near Wagon Camp in July; two were collected where the Hudsonian and Canadian zones meet, near Squaw Creek Camp, in August (August 9 and 17); one was seen there September 1, and two were shot in the Transition zone in September (one in Squaw Creek Valley September 13, the other at Sisson September 30). At Sisson R. T. Fisher saw three or four, during the first half of September, in the big fir west of Sisson Tavern.

39. *Dryobates pubescens gairdneri*. Gairdner Woodpecker.

Obtained at Sisson by C. H. Townsend August 3, 1883.

40. *Xenopicus albolarvatus*. White-headed Woodpecker.

A common breeder in the upper part of the pine belt, and also among the Shasta and white firs near Wagon Camp, where several specimens were collected, and where a nest-containing noisy young was found the latter part of July. The nest was in a stub in a burn, with the

entrance about 6 feet from the ground. At Sisson the white-headed woodpecker was seen, the middle of July, by Miss Merriam, and early in September by R. T. Fisher. In the pine woods bordering the south end of Shasta Valley I saw half a dozen September 29.

41. *Picoides arcticus*. Arctic Three-toed Woodpecker.

Rare, but evidently breeding in the Shasta fir forest of the Canadian zone, where a male was shot near Wagon Camp by John H. Sage July



Fig. 38.—Arctic Three-toed Woodpecker (*Picoides arcticus*).—Drawn by L. A. Fuertes.

20. Another was shot by Vernon Bailey July 30 in the gap between Red Cone and the lower end of Gray Butte, where a third individual was seen.

42. *Sphyrapicus ruber*. Red-breasted Sapsucker.

Fairly common at Wagon Camp, where specimens were collected in July by John H. Sage and Vernon Bailey. One was shot in Mud Creek Canyon about the end of July by R. T. Fisher, and one was seen at Sisson July 15 by Miss Merriam. September 18, one was seen in the brush along Little Shasta Creek by W. H. Osgood. In 1883 C. H. Townsend found the species "in midsummer in limited numbers on the heavily pine-timbered slopes of Mounts Shasta and Lassen."

43. *Spizrapicus thyroideus*. Williamson Sapsucker.

A male was killed August 4 by R. T. Fisher at timberline on the east side of Mud Creek Canyon. This was the only specimen collected, though others were seen near the same place. August 25, 1883, C. H. Townsend secured one at timberline on Shasta.

44. *Ceophloeus pileatus abieticola*. Pileated Woodpecker.

Fairly common about Wagon Camp, where their loud hammering and unmistakable cries were often heard. Several times in July one visited a tree on the edge of camp, and one was heard there the day we left, September 25. September 16, W. H. Osgood and R. T. Fisher saw three between Sisson and Edgewood.

45. *Melanerpes formicivorus bairdi*. California Woodpecker.

Seen from time to time among the oaks at Sisson, where one was shot by R. T. Fisher early in September.

46. *Melanerpes torquatus*. Lewis Woodpecker.

Common at Sisson and in Squaw Creek Valley near McCloud Mill. July 25 Miss Merriam saw one at Wagon Camp; August 2 W. H. Osgood killed one and saw others high up on Mud Creek Canyon; August 3 I saw a small flock in the Shasta fir forest between Mud and Squaw creeks; August 10 Walter K. Fisher shot one near Squaw Creek; and September 17-20 W. H. Osgood saw several in Shasta Valley.

47. *Colaptes cafer*. Red shafted Flicker.

Fairly common on the mountain; seen or heard nearly every day, during the latter half of July and early August, near Wagon Camp. July 28 several were seen on the lower slope between Wagon Camp and McCloud Mill; late in July and early in August several were seen high up on Squaw and Mud creeks; August 16 one was killed by R. T. Fisher at Squaw Creek Camp; and during migration, the latter half of September, a few were seen nearly every day a little below timberline near Squaw and Panther creeks. At the time of our visits to the juniper forest in Shasta Valley, September 19 and 29, flickers were common and were probably feeding on the juniper berries. At Sisson, Florence A. Merriam found them common, the middle of July, and R. T. Fisher, the first half of September.

48. *Phalænoptilus nuttalli*. Poor-will.

The unmistakable note of the poor-will was heard in July at Wagon Camp, where the species doubtless breeds. One of the birds was seen on Lower Squaw Creek near Warmcastle Soda Springs August 13 by W. H. Osgood. Others were heard near Edgewood by Walter K. Fisher.

49. *Chordeiles virginianus*. Nighthawk.

Often seen flying at Wagon Camp, on the lower edge of the Shasta fir forest, the latter part of July. Several flocks were seen at Sisson, the first half of September, by R. T. Fisher.

50. *Chætura vauxi* (?). Vaux Swift.

A couple of miles below Wagon Camp a small black swift was seen by Vernon Bailey about July 24. At Sisson numbers of swifts were seen September 1 and September 10 by R. T. Fisher, and on September 3 by Florence A. Merriam, but they flew too high to be shot.

51. *Aëronautes melanoleucus*. White-throated Swift.

Several were seen high up on Mud Creek Canyon early in August by W. H. Osgood.

52. *Calypte anna*. Anna Hummingbird.

Apparently breeding at Wagon Camp, where one was shot July 22 by John H. Sage. Breeds on the lower McCloud River (Townsend).

53. *Selasphorus rufus*. Rufous Hummingbird.

The commonest hummingbird of Shasta, breeding, apparently, from the lower edge of the Shasta firs to timberline, though it is possible that those seen at high altitudes had moved up to feed from the painted cups in the heather meadows after the breeding season was over. At Wagon Camp, where they were abundant in July and early August, they seemed to feed chiefly from the scarlet painted cup (*Castilleja miniata*).

54. *Stellula calliope*. Calliope Hummingbird.

Nearly as abundant as *Selasphorus rufus*, and the commoner of the two at high altitudes. In early August both species were constantly hovering over the superb flowers of the scarlet paint brush (*Castilleja miniata*) in the heather meadows near timberline. They were seen also visiting the large yellow blossoms of *Mimulus implexus*, which singular species forms mucilaginous beds in the little streams at and below timberline. Walter K. and R. T. Fisher found them abundant in Ash Creek Canyon about the first of August, particularly among the painted cups and delphiniums.

[*Trochilus alexandri* is recorded by C. H. Townsend as breeding along the lower McCloud, but was not obtained by us. In this connection it should be remembered that we did not collect hummingbirds in the low country, either at Sisson or in Squaw Creek Valley.]

55. *Tyrannus verticalis*. Arkansas Kingbird.

At Gazelle, on the west side of Shasta Valley, Vernon Bailey saw three on telegraph wires October 31. C. H. Townsend records the species as breeding on the lower McCloud River. In July, 1899, Walter K. Fisher found this kingbird common in Shasta and Little Shasta valleys.

56. *Sayornis saya*. Say Phoebe.

One was seen about an old windmill in Shasta Valley September 19 by W. H. Osgood.

57. *Contopus borealis*. Olive-sided Flycatcher.

Common at Wagon Camp, where several pairs reared families early in the season, and where, on July 22, Miss Merriam saw a parent bird feeding young in the nest, which was in a fir tree 30 to 40 feet from the ground. In July the species was also seen at Sisson, and in Mud Creek Canyon near the mouth of Clear Creek, on the north side of the mountain.

58. *Contopus richardsoni*. Western Wood Pewee.

A fairly common breeder at Sisson, where Florence A. Merriam saw old birds feeding young in the nest (in a fir tree) July 15.

59. *Empidonax difficilis*. Western Yellow-bellied Flycatcher.

On July 29 I shot one in a thicket of cherry bushes (*Cerasus emarginata*) on the boundary between the Canadian and Transition zones, a little west of Wagon Camp, where it was doubtless breeding.

60. *Empidonax hammondi*. Hammond Flycatcher.

A common breeder near Wagon Camp, in the lower edge of the Shasta firs, where several were collected late in July. Near Squaw Creek Camp, at the upper edge of the Shasta firs, one was shot August 21, and in Mud Creek Canyon at the mouth of Clear Creek, one was shot August 7.

61. *Empidonax wrighti*. Wright Flycatcher.

One was shot at Wagon Camp July 24 by John H. Sage.

62. *Otocoris alpestris merrilli*. Dusky Horned Lark.

Common in places in Shasta Valley, particularly about Montagne, where a number were secured by Walter K. Fisher. This is doubtless the form reported by C. H. Townsend, under the name *rubea*, as found "in limited numbers on the sage-covered districts north of Mount Shasta in midsummer." The locality referred to, he tells me, is in Shasta Valley, about 15 miles from the mountain.

63. *Pica pica hudsonica*. Magpie.

One was seen flying over the east side of Shasta Valley, near Sheep Rock, September 29 by Vernon Bailey and W. H. Osgood.

64. *Cyanocitta stelleri*. Steller Jay.

The form of Steller jay of the Shasta region is intermediate between true *stelleri* and the Sierra subspecies, *frontalis*.

It is one of the commonest, noisiest, and best-known birds of the region. Early in the season it was rarely seen above the lower part of the Canadian zone, and was most numerous in the Transition; but on August 2 one came all the way up to Squaw Creek Camp, in the alpine hemlocks, and a few days later a small flock was encountered, screaming, in Mud Creek Canyon at the mouth of Clear Creek. The latter half of September they were common at high altitudes and paid daily visits to our camp on upper Squaw Creek. At Sisson, apparently, they are always common.

65. *Aphelocoma californica*. California Jay.

Fairly common at Sisson, and more abundant in the lower country farther north. Seen by Vernon Bailey near Gazelle August 31, by W. H. Osgood among the junipers in Shasta Valley September 17 to 20, and by me in the undergrowth along the edge of the open pine and oak forest bordering the south end of Shasta Valley, where it was fairly common, September 29.

66. *Perisoreus obscurus*. Oregon Jay.

Unaccountably rare on Shasta during our stay. On August 6, when in a dense part of the forest east of the lower end of Gray Butte, I saw a flock of Steller jays, and with them several birds I took to be Oregon jays in the dark plumage of the young. August 20 Vernon Bailey shot one on Horse Camp Trail at an altitude of 6,600 feet, and two days later saw ten in the fir forest between Squaw Creek and Mud Creek Canyon. September 28, on his way around the mountain, he saw three above the point where the wagon road crosses Ash Creek, at an altitude of about 5,900 feet, by far the lowest point at which the species was seen. On July 29, 1899, Walter K. Fisher saw about 15 Oregon jays on Horse Camp trail.

In 1883 C. H. Townsend saw four small flocks (July 30 to September 7) in the heavily timbered forests of Mount Shasta.

67. *Corvus americanus*. Crow.

A few seen at Sisson. In July, 1889, Walter K. Fisher found them common in Shasta Valley.

68. *Nucifraga columbiana*. Clark Crow; Nutcracker.

Clark crows are among the most common, most characteristic, and most interesting birds of the higher slopes of Shasta. In summer they are closely restricted to the Hudsonian zone and adjacent rocky slopes immediately above timberline, but in fall they wander far and wide in search of food and are liable to be seen almost anywhere. Two or three, apparently young of the year, visited Wagon Camp, at the lower edge of the Shasta firs, as early as August 8; and in September it was not unusual to see small flocks or single individuals flying over the chaparral belt between Wagon Camp and Sissen.

The usual food of the Clark crow—the large nut-like seeds of *Pinus albicaulis*—having failed in 1898, the birds were feeding mainly on insects. The stomachs of specimens killed at extreme timberline contained in some cases grasshoppers only, in others chiefly beetles (Coleoptera); of those killed lower down, in the alpine hemlocks and Shasta firs, chiefly small hairless greenish caterpillars. They sometimes flew up to masses of yellow lichen, where they seemed to be picking out something to eat. On upper Squaw Creek, August 30, two were seen eating blueberries (F. A. M.). During hot afternoons the latter part of July they were often seen soaring and performing aerial antics above the forest, and also chasing insects in the air, launching out from the tree tops after them like flycatchers. As a rule, they are silent when

feeding and noisy when flying about the white-bark pines. When on the ground they are very deliberate, and their broad heads and general form suggest gulls, particularly when the birds are moving away from the observer.

When searching for insects in the young hemlocks they sometimes began at the bottom and worked up, sometimes at the top and worked down. One day in early August a young-of-the-year, showing the true nutcracker spots on the breast, spent some time in camp, feeding in a small tree in our midst without showing the least annoyance at our presence. He began at the top and worked slowly downward, dropping from branch to branch and peering searchingly over the foliage and into the tufts of hemlock needles, often hanging almost bottom



FIG. 39.—Clark Crow (*Nucifraga columbiana*). Drawn by L. A. Fuertes.

side up to pick off the small green caterpillars which infested both the hemlocks and the Shasta firs. We could plainly see him grasp the little caterpillars crosswise and give a big gulp in swallowing them, as if bolting something several times as large. He went over a branch at a time, examining the whole of it carefully before moving to the one below, and sometimes went out so far toward the tip that the slender branch bent down with his weight. Another bird reversed this order of procedure, and after finally reaching the top of the tree gave a jump, aided by a slight flap of the wings, and perched on the very top-most sprig, when, gaining his balance, he opened his bill and uttered a little cry of exultation.

Clark crows were almost daily visitors to our camp among the alpine hemlocks on upper Squaw Creek until near the end of August, when

they moved up to timberline to feed on the large wingless grasshoppers then abundant along the upper edge of the tongues of dwarf white-bark pines and on the lava-strewn pumice slopes at still higher elevations. Some were seen along the edge of the snow at an altitude of 11,000 feet, where dragon-flies, grasshoppers, and other insects were common.

Clark crow is a little larger than a blue jay, and his colors are put on in blocks. The body is gray; the wings and tail are black and white, in conspicuous contrast. Still, singular as it may seem, this coloration is both directive and protective. When in motion the bird is most conspicuous, the black and white patches flashing with great effect; but when quietly feeding on the ground among the gray lava rocks of the higher slopes it is not easily seen, the gray of the body resembling the gray rocks, the black markings the dark shadows. The coloration, however, is doubtless most protective at night when the bird is at roost in the trees and exposed to its worst enemies, presumably owls and martens. Contrasts of gray or white with black are among the most effective of disappearing colors at night—the black resembling patches of night shadow, the gray the interspaces.



Fig. 40.—Clark Crow (*Xueifraga columbiana*).
(Photographed by Walter K. Fisher.)

The true home of the Clark crow is among the white-bark pines of the rocky wind-swept ridges not far from the region of perpetual snow. Here, from the thaws of early spring till the storms of approaching winter, not a day passes without his presence. He is a bold, powerful bird, a fit tenant for such a home, where his loud cry wakes the echoes of glacier cliffs a thousand times oftener than it reaches a human ear.

69. *Cyanocephalus cyanocephalus*. Piñon Jay.

Not an inhabitant of Shasta, but occurs in migration about its base, and may breed in the junipers in Shasta Valley.

September 28, Vernon Bailey saw six in the chaparral and yellow pines at an altitude of 4,000 feet on the wagon road between Elk Creek and Ash Creek, and the next day found a few near Sheep Rock. At Fort Crook, a little southeast of Shasta, a number were collected some years ago by Captain Feilner.

70. *Xanthocephalus xanthocephalus*. Yellow-headed Blackbird.

Not observed by us, but in 1883 C. H. Townsend often saw it "among the flocks of Brewer blackbirds that frequented the timothy meadows of Berryvale, at the western base of Mount Shasta, 3,500 feet altitude." Berryvale is the old name for the meadows near Sisson Tavern.

71. *Agelaius phœniceus*. Red-winged Blackbird.

Common in Shasta Valley September 17 to 20 (Osgood). C. H. Townsend gives it as "an abundant summer resident of the cultivated country north of Mount Shasta."

72. *Sturnella magna neglecta*. Western Meadowlark.

Common in the meadowland at Sisson and Edgewood, and in the narrow meadows bordering Shasta River, in Shasta Valley. At Wagon Camp I saw one in a grassy opening August 13, and a few days earlier Walter K. Fisher saw one in a similar place a little higher on the mountain. In the Sisson Meadows ('Strawberry Valley'), during the first half of September, R. T. Fisher found meadowlarks "gathered in flocks of as many as a hundred birds."

73. *Icterus bullocki*. Bullock Oriole.

Common along streams in Shasta and Little Shasta valleys (W. K. Fisher). Vernon Bailey tells me that at Ager, in the north end of Shasta Valley, some silver poplars in a door yard are literally full of nests of this oriole, and that when he examined them June 26, 1899, the new nests contained young orioles and the old nests young house finches (*Carpodacus m. obscurus*).

74. *Scolecophagus cyanocephalus*. Brewer Blackbird.

Fairly common at Sisson and in Shasta Valley, but not observed on the mountain except in one instance, when several were seen at extreme timberline on the east side of Mud Creek Canyon August 24 by Vernon Bailey and Florence A. Merriam.



Fig. 41.—Western Evening Grosbeak (*Coccothraustes vespertinus montanus*.) Drawn by L. A. Fuertes.

75. *Coccothraustes vespertinus montanus*. Western Evening Grosbeak.

One of the commonest and most characteristic birds of the Shasta fir belt (Canadian zone), and much less common in the alpine hemlocks (Hudsonian zone). At Wagon Camp, near the lower border of the Canadian zone, small flocks were seen or heard daily whenever the camp was occupied, from the time of our arrival, the middle of July, until our departure, September 25. At Squaw Creek Camp, in the Hudsonian zone,

they were much less common, but still by no means rare, and during early August their distinctive call, a short whistle, was heard every day.

In September they were rarely observed on upper Squaw Creek, but September 18 a flock was seen near the head of Panther Creek. They were common in Mud Creek Canyon about the end of July and beginning of August. On September 29 I visited the juniper forest in Shasta Valley, and was surprised to find there dozens of evening grosbeaks, and still larger numbers of Townsend solitaires, feeding on the fat berries of the junipers (*Juniperus occidentalis*). At Sisson in September R. T. Fisher found flocks flying restlessly over the valley.

When in the molt the extraordinary color combinations of the males surpass even those of the crossbills.

76. *Carpodacus cassini*. Cassin Purple Finch.

A common summer resident in the Canadian and Hudsonian zones. Specimens were collected in July and August at various points from Wagon Camp, in the lower edge of the Shasta firs, to timberline, at the upper limit of *Pinus albicaulis*; and during our circuit of the mountain near timberline July 22 to 25 the species was heard or seen every day. At our camp in the alpine hemlocks on upper Squaw Creek, it was common and tame, and in early August usually began singing about daylight. On August 5 I saw one singing in a small white-bark pine on a ridge east of Mud Creek Canyon at an altitude of 8,800 feet, far above continuous timberline. A flock, probably migrating, was observed at the head of Panther Creek September 18.

77. *Carpodacus mexicanus obscurus* (McCall). House Finch.

[= *Carpodacus m. frontalis* Auct].¹

Common at Sisson and in Shasta Valley, but not seen on the mountain, where it is replaced by the preceding species. At Ager Vernon Bailey found it breeding abundantly in old nests of Bullock orioles.

78. *Loxia curvirostra bendirei* Ridgway. Sierra Red Crossbill.

Red crossbills are common on Shasta. Small flocks were heard nearly every day throughout the season and were frequently seen to light in the tops of the high firs, both at Wagon Camp and Squaw Creek Camp, but they never came into camp to feed, and were rarely seen near by. One was killed at Sisson September 12 by R. T. Fisher, who found the species common there at that time, feeding in the tall pines and also on the garden sunflowers. Several killed by us near timberline lodged in the dense foliage of the alpine hemlocks. C. H. Townsend obtained three specimens on Shasta. The crossbill of Shasta is intermediate between the northern subspecies *minor* and the southern subspecies *stricklandi*. It is the same as the Fort Klamath form named by Ridgway as subspecies *bendirei*; and specimens collected near Mount Whitney in the southern High Sierra by the Death Valley expedition, though published as *stricklandi*,² are practically indistin-

¹ For change of name see Oberholser, Auk, XVI, p. 186, April, 1899.

² North Am. Fauna, No. 7, p. 81, 1893.

gnishable. It is customary among ornithologists to name recognizable intergrades which have definite and clearly defined breeding ranges. On this basis *bendirei* seems entitled to stand, since it occupies the isolated crest of the Sierra Nevada of California from the southern end north to Shasta, and pushes on a short distance into southern Oregon (to Fort Klamath, its type locality). At Diamond Lake, in the southern Cascades, only a few miles north of Fort Klamath, subspecies *minor* occurs. The Diamond Lake specimen¹ was shot by my assistant, E. A. Preble, August 13, 1896, and is an adult male. Owing to the late date and to the well-known erratic habits of crossbills, this bird may have been a wanderer from farther north. Hence the actual northern breeding limit of *bendirei* and the southern breeding limit of *minor* remain to be established.

It is a singular fact that two of the specimens obtained by C. H. Townsend on Lassen, between Shasta and the High Sierra, are as large and have as large bills as *stricklandi*. They were killed in summer and may have been stragglers from some of the mountains to the southeast.

79. *Leucosticte tephrocotis* (?). Gray-crowned Leucosticte.

At an altitude of 10,000 to 11,000 feet, on the south side of Shasta Peak, Vernon Bailey saw half a dozen leucostictes August 17, and again the next day. They were feeding among the rocks and on the glacier which occupies the deep cross gulch just below Konwokitan glacier. He tells me they flew down into the crevasses just as we had seen them do on Mount Rainier the previous year. Since none were collected there may be some doubt as to the species. The Sierra bird is *tephrocotis*; the Rainier form *littoralis*.

80. *Astragalinus tristis salicamans*. Willow Goldfinch.

No specimens obtained, but I am sure I saw the species at Sisson in July and August with *A. psaltria*. Walter K. Fisher reports it as common in Little Shasta Valley.

81. *Astragalinus psaltria*. Arkansas Goldfinch.

Common at Sisson and in Shasta Valley; breeds at Sisson.

82. *Spinus pinus*. Pine Siskin.

Fairly common throughout the Shasta fir forest, and ranging thence upward into the alpine hemlocks and white-bark pines. Seen or heard at frequent intervals from the time of our arrival, the middle of July, until late in September.

83. *Ammodramus sandwichensis alaudinus*. Western Savanna Sparrow.

In Shasta Valley W. H. Osgood found this species common September 17 to 20, and just below timberline on Panther Creek I saw several September 18.

¹This specimen, an adult male, agrees with specimens of *minor* from Wrangel, Alaska, and Neah Bay and Lapush, Washington.

84. *Chondestes grammacus strigatus*. Western Lark Sparrow.

Not observed on the mountain, but seen at Edgewood August 31, and in the bushes bordering the narrow meadows on Shasta River, in the southwestern part of Shasta Valley, September 29. Ten days earlier W. H. Osgood reported them as common a little farther north in Shasta Valley. At Sisson R. T. Fisher saw two flocks the first half of September. In August, 1883, C. H. Townsend found the species abundant "on the high-lying plains northward of Mount Shasta." In July, 1899, Walter K. Fisher reported it as the commonest bird in Shasta Valley.

85. *Zonotrichia leucophrys*. White-crowned Sparrow.

Probably breeds near timberline in the Hudsonian zone, where, near the head of Mud Creek, one was shot August 4 by W. H. Osgood. About the middle of September numbers were seen just below timberline on Panther Creek—doubtless migrants—and a little later they were common in the bushes from Wagon Camp to Sisson and along Shasta River in Shasta Valley.

86. *Spizella socialis arizonæ*. Western Chipping Sparrow.

As the chipping sparrow is not an inhabitant of dense forests it was not seen in the Shasta fir belt; but in the openings along the lower edge of this belt it breeds, and was feeding young at Wagon Camp in July. After the breeding season it was seen from time to time near timberline. It is a common breeder at Sisson and in Shasta Valley.

87. *Junco hyemalis thurberi*. Sierra Junco.

Common from timberline down to the lower edge of the Shasta firs. The commonest 'ground bird' of the forest. Several nests with eggs or young were found near Wagon Camp the latter part of July.

88. *Melospiza melodia montana*. Mountain Song Sparrow.

Song sparrows supposed to be this subspecies were found breeding at Wagon Camp and Sisson the middle of July. Others were seen in the tules at Big Spring, in Shasta Valley, September 17 to 20 by W. H. Osgood. One was secured at Edgewood July 19, 1899, by Walter K. Fisher, who states that it was the only one seen during his stay.



FIG. 42.—White-crowned Sparrow (*Zonotrichia leucophrys*). Drawn by L. A. Fuertes.

89. *Melospiza lincolni*. Lincoln Sparrow.

Breeds along the edge of the forest at Wagon Camp, where I shot one at the spring July 20. Another was obtained by R. T. Fisher on Squaw Creek (alt. about 6,700 feet) August 17. Others were seen among the alders in Mud and Ash Creek canyons about the end of July by Walter K. Fisher. At Sisson, the first half of September, R. T. Fisher found the species fairly common, and shot one among the alders bordering Cold Creek. W. H. Osgood reported it as common in Shasta Valley September 17 to 20.

90. *Passerella iliaca unalaschcensis*. Townsend Sparrow.

Common during migration (September) throughout the chaparral of the lower slopes from Sisson up to Wagon Camp. At Wagon Camp one was shot by W. H. Osgood September 22. Common also late in September in bushes in the more open parts of the forest along the east base of Scott Mountains from Sisson north to Edgewood, and in the bushes bordering Shasta River in the southern part of Shasta Valley.

Passerellas supposed to be this species were seen repeatedly at Sisson, the first half of September, by R. T. Fisher.

91. *Passerella iliaca megarhyncha*. Thick-billed Sparrow.

Breeds near Wagon Camp, apparently in the chaparral, where John H. Sage shot one July 20 and another July 22. At Sisson W. H. Osgood and Miss Merriam saw this species July 13 and 15. In the summer of 1883 C. H. Townsend found it a common breeder in the chaparral tracts of Shasta.

92. *Pipilo maculatus megalonyx*. Spurred Towhee.

Common in the undergrowth along the edges of openings in the ponderosa pine forest from Sisson to Shasta Valley. One was shot at Upton September 15 by R. T. Fisher. C. H. Townsend found it breeding commonly on the lower slopes of Shasta in 1883.

93. *Pipilo fuscus crissalis*. California Towhee.

Several seen in the chaparral near Gazelle August 31 by Vernon Bailey, and near Edgewood by Walter K. Fisher.

94. *Oreospiza chlorura*. Green-tailed Towhee.

Apparently a fairly common breeder on the lower slopes of Shasta, where in the chaparral near Wagon Camp several were seen and one was killed the latter part of July and early in August, and one was found feeding full-grown young July 28. At Sisson Miss Merriam found them the middle of July. The last one noted by me was seen in the manzanita at an altitude of 4,900 feet, on the road from Wagon Camp to Sisson, August 26.

95. *Zamelodia melanocephala*. Black-headed Grosbeak.

Seen at Sisson by W. H. Osgood July 13. At the McCloud River fish hatchery C. H. Townsend found it a common breeder in 1883.

96. *Cyanospiza amœna*. Lazuli Bunting.

Common at Sisson (where it was seen feeding young July 15 by Miss Merriam), and ranging thence up through the chaparral of the Transition zone all the way to Wagon Camp, where a nest was found and the parent secured July 17 by W. H. Osgood, who obtained another in Mud Creek Canyon August 3.

97. *Piranga ludoviciana*. Mountain Tanager.

One of the commonest, as well as handsomest, birds of the Shasta fir forest. At Wagon Camp, at the lower edge of the Canadian zone, these tanagers were seen every day from the middle of July until August 10, when that camp was temporarily abandoned. They were very tame, and spent much time in camp, drinking from our little spring and peering at us from the lower branches of the firs. On July 21 I saw several picking caterpillars from the leaves of the buck brush (*Ceanothus velutinus*) in an opening in the firs. Walter K. Fisher states that one sang continuously at his camp in Mud Creek Canyon at the mouth of Clear Creek about the end of July. At Sisson this tanager was seen July 15 by Miss Merriam.

98. *Progne subis hesperia*. Western Martin.

Not observed by us, but recorded by C. H. Townsend, who, in 1883, noticed a few "about some buildings at the west base of Mount Shasta in midsummer." One seen about 6 miles northwest of Edgewood by Walter K. Fisher.

99. *Petrochelidon lunifrons*. Cliff Swallow.

Common at Sisson, where it was noted by Miss Merriam the middle of July, and by R. T. Fisher the first half of September. Abundant in Shasta Valley (W. K. Fisher).

100. *Hirundo erythrogastra*. Barn Swallow.

Common at Sisson, and seen in Shasta Valley September 17 to 20 by W. H. Osgood. Common in Shasta Valley in July (W. K. Fisher).

101. *Tachycineta thalassina*. Violet-green Swallow.

Common at Sisson, and seen once or twice flying over the chaparral, nearly up to Wagon Camp.

102. *Tachycineta bicolor*. Tree Swallow; White-bellied Swallow.

Swallows believed to be this species were seen several times between Wagon Camp and Sisson, and C. H. Townsend records them as abundant breeders on the lower McCloud.

103. *Stelgidopteryx serripennis*. Rough-winged Swallow.

Walter K. Fisher saw some swallows at Edgewood in July, 1899, which he believed to be this species.

104. *Lanius ludovicianus excubitorides*. White-rumped Shrike.

One seen at Gazelle, on the west side of Shasta Valley, August 31, by Vernon Bailey, and one in Shasta Valley September 18 by W. H. Osgood. Rather common in Shasta Valley in July, 1899 (W. K. Fisher).

105. *Vireo solitarius cassini*. Cassin Vireo.

Fairly common along the lower border of the Shasta fir forest at Wagon Camp, where two or three were obtained the latter part of July, and where a nest containing one egg and one young was found by John H. Sage July 31. The nest was in a clump of buck-brush (*Ceanothus velutinus*) only 3 feet above the ground, in open chaparral, near the edge of the Shasta fir woods.

106. *Vireo gilvus swainsoni*. Western Warbling Vireo.

Recorded by C. H. Townsend as "found at rare intervals in midsummer about the base of Shasta." A vireo heard by us several times at Sisson was probably this species. Walter K. Fisher found it at Edgewood, among the bushes along Shasta River, where he secured a specimen July 19, 1899.

107. *Helminthophila rubricapilla gutturalis*. Calaveras Warbler.

Common in the chaparral at Wagon Camp, where several specimens were collected the last half of July. Later the species was seen with other warblers in the trees higher up on the mountain.

108. *Helminthophila celata lutescens*. Lutescent Warbler.

Fairly common and apparently breeding at Wagon Camp, in the lower edge of the Shasta firs, where two were collected July 20. One was shot in the alpine hemlocks on Squaw Creek August 6 by Vernon Bailey.

109. *Dendroica æstiva*. Yellow Warbler.

Seen at Sisson, the middle of July, by Miss Merriam. The only one seen on the mountain was shot in the chaparral near the edge of the fir forest at Wagon Camp July 29 by John H. Sage. Common in bushes along Shasta River in Shasta Valley (W. K. Fisher).

110. *Dendroica auduboni*. Audubon Warbler.

Abundant throughout the forest region of Shasta, from timberline down to the lower edge of the Canadian zone. At Wagon Camp Miss Merriam saw them feeding fullgrown young July 18 and August 1. In August and September they were seen daily at our camp in the alpine hemlocks, often in mixed flocks of chickadees and other birds. When we left Wagon Camp, September 25, they were still common there.

August 9 and 10, spotted young were collected, one with the brown sides coming in and one with the yellow just beginning to show. At



FIG. 43.—Audubon Warbler (*Dendroica auduboni*). Drawn by L. A. Fuertes.

Sisson, Miss Merriam saw them the middle of July, and R. T. Fisher found them common the first half of September.

111. *Dendroica occidentalis*. Hermit Warbler.

Fairly common in the Hudsonian and upper part of the Canadian forest during August (collected at Squaw Creek Camp at intervals from August 3 to August 28); not seen in July.

112. *Geothlypis tolmiei*. Macgillivray Warbler.

Seen at Sisson and Wagon Camp about the middle of July, and again at the latter locality August 1 and August 3. One was shot in Mud Creek Canyon at an altitude of 6,700 feet by W. H. Osgood August 7. In July and August, 1883, C. H. Townsend found it not uncommon on the mountain.

113. *Geothlypis trichas occidentalis*. Western Yellow-throat.

At Big Spring, in Shasta Valley, W. H. Osgood found this warbler common in the tules September 17 to 20; and August 6, 1883, C. H. Townsend secured an immature specimen at the base of Mount Shasta.

114. *Icteria virens longicauda*. Long-tailed Chat.

Fairly common at Sisson, and common in the lower country farther north—at Gazelle and on toward Yreka. Common along Shasta River in Shasta Valley (W. K. Fisher).

115. *Wilsonia pusilla pileolata*. Pileolated Warbler.

Common in Mud Creek Canyon the latter part of July and early August: seen at Sisson July 13 by W. H. Osgood, and at Wagon Camp August 3 by Miss Merriam; several seen at Squaw Creek in flocks of chickadees and warblers during August and September; seen in wild cherry bushes at Wagon Camp September 25. In the summer of 1883 C. H. Townsend found it rather common on Shasta.

116. *Anthus pensilvanicus*. Pipit; Titlark.

In a barren rocky basin above timberline, near the head of Panther Creek, on July 17 I heard titlarks and saw Arctic bluebirds. At the same place two months later (September 18) titlarks were common. In Shasta Valley September 17 to 20 W. H. Osgood saw flocks along the road.

117. *Cinclus mexicanus*. Dipper; Water Ouzel.

Common on the upper part of Squaw Creek as far as the timber extends, and sometimes seen above timberline. Seen also on Panther Creek, near its head, and on Mud and Ash creeks. On Squaw Creek we often watched the ouzels feeding among the cascades and clear cold pools between the upper heather meadow and the main fall. One afternoon just before dark (6 o'clock) I was surprised to see an ouzel fly up into the dead top of a tree, light on a branch, and climb up several feet on the trunk with his short tail hanging straight down, after the manner of a woodpecker.

118. *Salpinctes obsoletus*. Rock Wren.

Rather rare on Shasta and confined apparently to the bare rocky slopes near and above timberline. August 2, at an altitude of 8,600 feet, on one of the ridges above the head of Squaw Creek, I found a pair—the first noted on the mountain. August 11, on the west rim of Mud Creek Canyon, I first heard them at 9,000 feet, and Vernon Bailey followed them up and shot one at 9,800 feet. A week later he saw one at an altitude of 10,400 feet. August 27, Miss Merriam saw one in 'The Gate,' between the heads of Panther Creek and Squaw Creek. In 1883 C. H. Townsend found them common above timberline on Shasta, and observed them also on Sheep Rock. In July, 1899, Walter K. Fisher found them among lava ledges in Shasta Valley.

119. *Catherpes mexicanus punctulatus*. Canyon Wren.

Not observed by us, but recorded by Townsend, who in 1883 saw one—doubtless a straggler—above timberline on Shasta, and others at Sheep Rock, at the northeast base of the mountain, where he heard the bird's wonderful song and was deeply impressed by it.

120. *Thryomanes bewicki spilurus*. Vigors Wren.

Seen at Sisson, but not on the mountain. Recorded by C. H. Townsend from "the base of Shasta."

121. *Troglodytes ædon parkmani*. Parkman Wren.

Rare on the mountain. One collected near Squaw Creek Camp (alt. 6,750 feet) August 18 by R. T. Fisher, and one in Mud Creek Canyon (alt. 6,780 feet) August 9 by W. H. Osgood. More common at Sisson, where it was observed by Miss Merriam the middle of July. C. H. Townsend records it as abundant in midsummer "among the piled-up logs of a certain clearing in the forest at the base of Mount Shasta." The bird seems to be intermediate between *parkmani* and *aztecus*.

122. *Cistothorus palustris paludicola*. Tule Wren.

At Big Spring, in Shasta Valley, W. H. Osgood found these wrens common September 17 to 20.

[The western winter wren (*Anorthura hiemalis pacifica*) was not observed by us, but was found by C. H. Townsend in the mossy canyons of the lower McCloud. It doubtless occurs in the upper canyon of the Sacramento near Sisson, and quite possibly in other suitable places about the mountain.]

123. *Certhia familiaris occidentalis*. Western Brown Creeper.

Not common, but seen now and then in the alpine hemlocks on Squaw Creek and in the Shasta firs, lower down. The earliest record is July 24 (J. H. S.); the latest, September 15 (C. H. M.). At Wagon Camp John H. Sage shot one and saw another July 27; and Miss Merriam saw one in the same place August 1, one at Squaw Creek August 30, and two at Sisson September 3.

124. *Sitta carolinensis aculeata*. Slender-billed Nuthatch.

Not common on the mountain, and only moderately so at Sisson. A few were seen at Squaw Creek Camp from time to time in August, once or twice in the mixed flocks of chickadees and warblers.

125. *Sitta canadensis*. Red-breasted Nuthatch.

Common from the lower edge of the Shasta fir belt up to timberline; and from the time of our arrival, the middle of July, until our departure, the latter part of September. In September it was often seen in mixed flocks with mountain chickadees and Audubon warblers.

126. *Sitta pygmæa*. Pigmy Nuthatch.

In the ponderosa pines near Sisson, W. H. Osgood saw pigmy nuthatches July 13, and I saw a small flock September 30. At the southwest end of Shasta Valley, not far from Edgewood, Osgood saw several in the pines September 20.

127. *Parus gambeli*. Mountain Chickadee.

Common and widely distributed. In the firs at Wagon Camp they were among the commonest birds, and at higher altitudes were seen or heard nearly every day. Early on the morning of July 24, after camping for the night in the shelter of a narrow fringe of dwarf white-bark pines at timberline, on one of the desolate torrent-swept beds of Inconstance Creek, high up on the north side of Shasta, we were saluted by a small flock of these cheerful little birds. In September they helped form the mixed flocks, along with Audubon and other warblers, Canada nuthatches, and other small fry so often seen among the Shasta firs and alpine hemlocks. At Sisson Miss Merriam saw them about the middle of July; they were common there in September, and were noted in Shasta Valley by W. H. Osgood September 17 to 20.

128. *Parus rufescens*. Chestnut-backed Chickadee.

Not observed by us, but recorded by C. H. Townsend, who "obtained a single individual at the western base of Mount Shasta on July 14, 1883."

129. *Psaltriparus minimus californicus*. California Bush-Tit.

Common along Little Shasta Creek September 18 (W. H. Osgood). Seen in the chaparral west of Gazelle, on the west side of Shasta Valley, August 31 (Vernon Bailey). Townsend found it a common breeder near the fish hatchery on the Lower McCloud River.

130. *Regulus satrapa olivaceus*. Western Golden-crowned Kinglet.

Both kinglets are common on Shasta and doubtless breed in the Shasta firs of the Canadian zone. The golden-crown was often seen and heard at Wagon Camp, where it was collected July 18. It was also common just within the lower edge of the fir forest in Mud Creek Canyon July 23, and a couple of miles higher up about the end of the month. C. H. Townsend obtained specimens at timberline in July, 1883.

131. *Regulus calendula*. Ruby-crowned Kinglet.

The ruby-crown was frequently heard by various members of the expedition, and at different altitudes, from Wagon Camp in the lower edge of the Shasta firs, to timberline, where one was collected by W. H. Osgood August 4. In 1883 C. H. Townsend obtained two specimens, one at timberline August 15, the other at an elevation of about 6,000 feet September 2.

132. *Myadestes townsendi*. Townsend Solitaire.

Not an uncommon breeder on the higher slopes of Shasta, where I saw six during our stay. The lowest of these was at Wagon Camp, in the lower edge of the Shasta firs, where one drank at our spring July 31. The others were in the Hudsonian zone, and most of them in the alpine hemlocks at or near our camp on Squaw Creek, just below timberline.

They were usually seen in early evening when they came to drink from the little streams in the forest, and were always silent and rather shy. Late in July and early in August they were seen with arctic bluebirds by Walter K. Fisher at and below timberline near Mud Creek Canyon. They probably winter in the junipers in Shasta Valley, where W. H. Osgood saw them September 17 to 20, and where I saw dozens feeding on the juniper berries and singing freely September 29. Late in July, 1883, C. H. Townsend found one of these birds "frozen in the snow and ice which filled the crater of the extinct volcano of Shasta."

133. *Hylocichla aonalaschkæ auduboni*. Dwarf Hermit Thrush.

Evidently breeds in the dark Shasta fir forest of the mountain and in the damp forest of white and Douglas firs near Sisson Tavern, where Miss Merriam heard them in full song the middle of July. At Wagon Camp W. H. Osgood shot one July 17; and near Squaw Creek Camp I shot another September 20. C. H. Townsend records it from the southern slope of Shasta under date of July 25.

134. *Merula migratoria propinqua*. Western Robin.

Robins were fairly common at Wagon Camp, where we heard their evening song the day of our arrival, July 15, and where they were seen carrying food to young July 26 (F. A. M.). Higher up they were seen from time to time, but were not common. Along the upper part of Mud Creek Canyon Walter K. Fisher found them "fairly common but erratic" the latter part of July and first few days of August. At Squaw Creek Camp, in the alpine hemlocks, we saw a flock on the morning of August 12, and others September 15. Just below timberline on Panther Creek a few were seen migrating September 18. In Shasta Valley they were common among the junipers September 29. At Sisson they are common breeders, and a few were seen whenever any of our party were there, from July 14 until the end of September. A nest containing three eggs was found July 13 by W. H. Osgood.

135. *Sialia mexicana occidentalis*. Western Bluebird.

A common breeder at Sisson, where families, including lately fledged young, haunted the fences the first half of September (R. T. Fisher). In Shasta Valley W. H. Osgood found them common September 17 to 20, and a few small flocks were seen by me among the junipers September 29. At Sisson the species was common the latter part of September. In 1883 a nest containing nearly grown young was found by C. H. Townsend in a post hole in the ground at Sisson Tavern late in July.

136. *Sialia arctica*. Mountain Bluebird; Arctic Bluebird.

A common breeder on the higher slopes of Shasta, where they were constantly seen in July and early August, but rarely afterwards. On our first visit to timberline, July 17, they were very abundant on the

bare rocks above timberline near the head of Panther Creek, and a week later were seen on the rim of Mud Creek Canyon. On the rocky slopes at and above timberline on the east side of Mud Creek Canyon early in August they were the most characteristic birds (W. K. Fisher); and they were seen near the same place August 18 (V. Bailey). September 20 a small flock visited our camp on upper Squaw Creek.

In July, 1883, C. H. Townsend found the species abundant at timberline, where full fledged young accompanied their parents.

NOTES ON THE DISTRIBUTION OF SHASTA PLANTS.

The study of the geographic distribution of animals and plants in the Sierra-Cascades can not be completed until authentic lists of species are brought together from several important localities from which at present no data are available. The need of such lists, with detailed altitudes and zone positions, is particularly urgent in the case of detached mountains, as Shasta and Lassen, which are separated from each other and from the continuous ranges on either side by gaps low enough to be broadly filled by Transition zone species. The Boreal species of these mountains, being thus completely cut off from the nearest corresponding colonies, form islands in the long Boreal chain that stretches southward from British Columbia to southern California.

The present imperfect list of the plants of Mount Shasta is offered as an humble contribution toward the needed material. It is based almost wholly on my own personal observations and is known to be far from complete. More pressing work along other lines made it impracticable to give much time to plants, and the date of arrival at the mountain (the middle of July) was so late that many of the early flowering species had disappeared. The Boreal species, owing to their greater importance, have received most attention; the Transition zone species least. In the case of Alpine and Hudsonian species it is believed that few remain to be added.

I am indebted to Miss Lewanna Wilkins for collecting and pressing most of the plants preserved during the first six weeks of our stay on the mountain; and to John H. Sage for the use of a collection made by him during the same period. The plants obtained subsequent to August 8 were collected by Vernon Bailey and myself.

Although two seasons' field work in the Cascade Range had given me a certain acquaintance with the more conspicuous plants common to these mountains and Mount Shasta, I was still much handicapped in the determination of the species, and not being a botanist myself was obliged to appeal to professional botanists for assistance. I am indebted most of all to Miss Alice Eastwood, curator of the herbarium of the California Academy of Sciences, whose courtesy and promptness in identifying plants, sent her from time to time while I was still in the field, were of the utmost assistance. I am also particularly indebted to Prof. E. L. Greene, of the Catholic University at Washington, who has taken the trouble to examine a large number of species, and to describe several which proved to be new. Other bota-

nists who kindly determined special species or special genera are Mrs. N. L. Britton, Mr. Frederick V. Coville, Prof. W. R. Dudley, Mr. M. L. Fernald, Mr. John B. Leiberger, Mr. C. L. Pollard, Dr. B. L. Robinson, Dr. J. N. Rose, Prof. P. A. Rydberg, Mr. J. K. Small, and Prof. William Trelease. In order to properly place the credit for this assistance, the botanist responsible for the identification is in each instance mentioned. Where no one is named I am personally responsible.

A few mosses and ferns were found in the timberline region of Shasta. The mosses, kindly determined by Mrs. Britton, are *Harpidium* (? *crannulatum* Gumb.), *Aulacomnium androgynum* Sch., and a species of *Philonotis*. They are confined rather closely to the borders of the alpine streams, where the *Aulacomnium* forms compact mats of a yellowish color.

The ferns have been determined by Mr. William R. Maxon through the courtesy of Mr. Frederick V. Coville, curator of the National Herbarium. The species which grow sparingly in the heather meadows and under the edges of rocks near timberline are: *Dryopteris aculeata scopulina* (Eaton), *Cystopteris fragilis* (L.) Bernh., *Cheilanthes gracillima* D. C. Eaton, *Cryptogramme acrostichoides* R. Br., and *Phegopteris alpestris* (Hoppe) Mett. Much lower down, along the boundary between the Canadian and Transition zones, *Pteris aquilina lanuginosa* (Bory) Hooker, and *Asplenium filixfemina* (L.) Bernh. occur. The brake (*Pteris*) is very abundant on the pumice sand at Wagon Camp and Sisson and wherever there is sufficient moisture in the soil in spring and early summer. The black-beard lichen (*Alectoria fremonti*) and the handsome yellow tree lichen (*Ermania vulpina*) abound in the dark forest of Shasta firs.

In the chapter on 'Life Zones' the more distinctive species have been grouped according to their vertical distribution (see pp. 52-68), but for convenience in finding the notes relating to particular species, they are here arranged in systematic order. In the case of certain plants found by us only on the borderland between adjacent zones, the zone position is in doubt and must be determined by future study.

The most important kinds of plants from the standpoint of geographic distribution are naturally those that remain longest in a particular spot. Hence, as pointed out by Coville,¹ trees, shrubs, and perennials are the kinds most useful in determining zone boundaries. For this reason little attention is here given to annuals.

Pinus monticola Douglas. Silver Pine; Mountain White Pine.

Common in places, chiefly in the upper half of the Canadian zone, but local and by no means generally distributed. Wherever it occurs it is mixed with Shasta firs, and in places it reaches up high enough to overlap the lower edge of the black alpine hemlocks and white-bark timberline pines. (See p. 38.)

¹ Botany of Death Valley Expedition, pp. 17-18, 1893.

***Pinus lambertiana* Douglas.** Sugar Pine.

Fairly common in most parts of the Transition zone forest of ponderosa pines, and occurring here and there in the immense areas of chaparral that cover the lower slopes on the south and west sides of the mountain. (See pp. 32-33.)

***Pinus albicaulis* Engelmann.** White-bark Pine.

The timberline tree of Shasta, which it encircles at altitudes ranging, according to slope, from about 7,000 up to 8,000 feet, and pushing up on the warmest ridges to an extreme elevation of 9,800 feet. In its distribution therefore it fills the Hudsonian zone except in places unsuited to tree growth. The only tree competing with it on Shasta is the black alpine hemlock, which, requiring more moisture, is at a disadvantage and is confined to special localities, as explained in full under that species. (See pp. 39-42.)

***Pinus ponderosa* Laws.** Ponderosa or Yellow Pine.

The most abundant and characteristic tree of the lower slopes and basal plane of Shasta, where, filling the Transition zone, it forms a continuous open forest of wide extent. (See pp. 30-32.)

***Pinus murrayana* Balfour.** Lodge-pole Pine.

Confined to the northeast quadrant of Shasta, where it occupies the lower part of the Canadian zone. (See pp. 38-39.)

***Pinus attenuata* Lemmon.** Knobcone Pine.

Common in a limited area in the Transition zone on the south side of Shasta, where it is confined to the lower slopes (from about 4,000 to 5,600 feet altitude) from Panther Creek easterly to between the branches of Mud Creek. (See pp. 33-34.)

***Tsuga mertensiana* (Bong.) Carr.¹** Black Alpine Hemlock.

A characteristic tree of the Hudsonian zone, where, however, it is not generally distributed for the reason that the upper slopes of Shasta are in most places too dry for it. It occurs in the same belt with *Pinus albicaulis*, but does not reach so high, and, requiring more moisture, is confined to disconnected localities, usually in canyons and gulches or along the shady sides of buttes or ridges. (See pp. 42-46.)

***Pseudotsuga mucronata* (Raf.).** Sudw. Douglas Fir or Spruce.

Common, scattered through the less arid parts of the forest of ponderosa pines which clothes the lower Transition zone slopes of Shasta and extends away in all directions (see p. 32). A subspecies *pendula* (Engelm.) Sudworth, with "branches, at least the lower ones, very slender and long-pendent," has been described from Sisson (Bot. Calif., II, 483, 1880; Sudworth, Check List Forest Trees of U. S., 24, 1898), and is common thence westerly to the coast. (See pp. 34-35.)

¹ For change of name from *Tsuga pattoni* to *T. mertensiana*, see footnote p. 42.

***Abies shastensis* Lemmon. Shasta Fir.**

The dominant tree of the Canadian zone, covering the middle slopes and completely encircling the mountain in a solid belt about 2,000 feet in vertical breadth. Its upper border overlaps the lower edge of the Hudsonian; its lower border, the upper edge of the Transition. Along Panther and Squaw creeks, on the south slope, it ranges from about 5,500 up to 7,500 feet, and on steep southwesterly slopes considerably higher. (See pp. 36-38.)

***Abies concolor lowiana* (Murray) Lemmon. White Fir.**

The common and only true fir of the basal slopes of Shasta, where it occurs in moist places from the altitude of Wagon Camp (5,700 feet) down to the very bottom of Sisson Valley at the base of Mount Eddy (alt. 3,400 feet). It thus fills the Transition zone, except in places that are too dry for it. (See p. 34.)

***Libocedrus decurrens* Torrey. Incense Cedar.**

Common throughout the Transition zone forest of ponderosa pines, except in the driest places. (See p. 35.)

***Chamæcyparis lawsoniana* (Murray) Parlat. Lawson Cypress.**

Attributed to "the Shasta Mountains" (Bot. Calif., II, p. 115, 1880), but not found by us.¹

***Juniperus nana* Willd. Dwarf Alpine Juniper.**

Fairly common in places close to timberline, usually associated with *Pinus albicaulis* in the upper part of the Hudsonian zone. On Shasta it usually grows in small patches less than a foot high and, as a rule, only a few feet in diameter; in the Olympics, on Mount Rainier, and on numerous other mountains it forms much larger patches. Between Mud Creek Canyon and the high ridges above Squaw Creek, it pushes up to extreme timberline at 9,800 feet, along with *Pinus albicaulis*. On the north side of Shasta and Shastina it was found in crevices among the sharp lava rocks at altitudes varying from 8,300 to 9,000 feet, and was common on the curious *albicaulis* plain stretching westerly from 'North Gate' to Bolam Creek.

***Juniperus occidentalis* Hooker. Western Juniper.**

Abundant in the south end of Shasta Valley, where it forms a forest many miles in extent. Scattered trees begin 4 or 4½ miles easterly from Edgewood, and become more and more plentiful to the north until, at a distance of about 5 miles south from Big Spring, they suddenly become abundant and cover the whole country east of the main mass of lava buttes, forming a continuous juniper forest which fills the southern part of Shasta Valley and reaches northward, I am told, into Little

¹Another cypress attributed to Shasta but not seen by us is *Cupressus macnabiana* Murr., "originally reported by Jeffrey from Mount Shasta at 5,000 feet altitude" (Bot. Calif., II, p. 111, 1880). In both instances, probably, the term 'Shasta' was used in a rather loose sense, as covering adjacent mountains not then named.

Shasta Valley. When visited about the end of September, the trees were full of their large berries, and many birds, including evening grosbeaks and Townsend solitaires, were there in numbers feeding on them. The zone position of this tree, which appears to be the type form, is high Upper Sonoran and low Transition. The boreal form common in the Sierra, but not found on Shasta, should be different.

Sitanion cinereum J. G. Smith. Alpine Grass.

The common grass of the glacial meadows, but nowhere sufficiently abundant to form anything like a sod. It is closely related to *S. elymoides* Raf., from which it has been recently separated by Mr. Jared G. Smith.

Carex breweri Boott. Alpine Carex.

Common in the glacial meadows and scattered sparingly over the moist slopes. (Identified by F. V. Coville.)

Juncus parryi Engelm. Parry Juncus.

Common in the heather patches and other moist places from slightly below timberline up through the Alpine zone. Noted by Vernon Bailey as high as 11,300 feet. (Identified by F. V. Coville.)

Allium validum Watson. Large Wild Onion.

Abundant in the Canadian zone along the streams of the Shasta fir belt, and often growing in the lower heather beds along the lower border of the Hudsonian zone. (Identified by Professor Greene.)

Allium sp. — ?

A very small species is common in the glacial meadows at the head of Squaw Creek, but matures so early that we were unable to obtain anything but the bulbs.

Calochortus nudus Watson.

Fairly common along the lower edge of the Canadian zone near Wagon Camp, flowering late in July. (Identified by Miss Eastwood and Professor Greene.)

Calochortis maweanus Leichtlin.

Not rare at Wagon Camp, but not seen elsewhere. An elegant little species with white hairy flowers. (Identified by Professor Greene.)

Fritillaria atropurpurea Nutt.

Common in the chaparral of the Transition zone basal slopes from Sisson up to Wagon Camp. (Identified by Miss Eastwood.)

Hastingsia alba (Durand) Wats.

Common near Wagon Camp, where its long and slender cylindrical spikes were in flower the latter part of July. (Identified by Miss Eastwood and Professor Greene.)

Lilium parvum Kellogg. Tiger Lily.

Common in marshy places in the lower part of the Shasta fir belt, particularly at Wagon Camp, where it was flowering abundantly about

the middle of July, and was still in fruit as late as the end of September. (Identified by Miss Eastwood.)

Lilium washingtonianum Kellogg. Washington Lily.

This superb lily, with large white and very fragrant flowers, is common in the manzanita in the upper part of the Transition zone, and occurs sparingly at lower altitudes. At Sisson it was in fruit the end of September. The flowers had passed their prime by the middle of July, but occasional plants were found in blossom as late as the end of the month.

Tofieldia occidentalis Watson.

Common near the bottom of the Canadian zone at Wagon Camp. (Identified by Professor Greene.)

Tritelia ixioides (Ait.) Greene (= *Brodiaea*).

Common at Wagon Camp on the border between the Canadian and Transition zones, where its yellow star flowers were in bloom the latter half of July. (Identified by Professor Greene.)

Vagnera stellata (Linn.) Morong.

Common at Wagon Camp, particularly in open grassy places along the edges of the fir forest, where it was flowering abundantly when we reached the mountain, the middle of July. Plants still holding their fruit were observed when we left Wagon Camp, September 25.



FIG. 44.—White Hellebore (*Veratrum californicum*).
Photographed by W. K. Fisher.

Veratrum californicum
Durand. White
Hellebore.

Abundant at numerous localities along the streams and in marshy spots in the Canadian and upper part of the Transition zones. Particularly common at Wagon Camp, and also on Squaw Creek just above the middle meadow.

Smilax californica Gray. California Smilax.

Occurs in places in the lower part of the Transition zone along Shasta River between Edgewood and Sisson, but nearer Sisson. Not observed elsewhere.

Sisyrinchium bellum Watson. Blue-eyed Grass.

Fairly common in the Transition zone near Wagon Camp.

Corallorhiza bigelovi Watson.

Not uncommon in the woods near Wagon Camp. (Identified by Professor Greene.)

Habenaria leucostachys (Lindl.) Watson.

Common in the marsh at Wagon Camp. (Identified by Professor Greene.)

Habenaria unalaschensis Watson.

A boreal species, fairly common in the marsh near Wagon Camp, growing with the last. (Identified by Professor Greene.)

Populus trichocarpa T. & G. Western Balsam Poplar.

Common in the upper Sacramento Canyon near Sisson, and less so along Shasta River at the south end of Shasta Valley.

Salix lasiandra Benth. Black Willow.

Abundant in cool moist places about Sisson. (Identified by Miss Eastwood.)

Salix nuttalli Sargent. Nuttall Willow.

Common in moist places in canyons of the Canadian zone and near Wagon Camp. (Identified by F. V. Coville.)

Salix sitchensis Sanson. Sitka Willow.

Common in canyons in the Canadian zone. Found in Mud Creek Canyon near the mouth of Clear Creek. (Identified by F. V. Coville.)

Alnus rhombifolia Nutt. White Tree Alder.

Observed only on Shasta River in the southern part of Shasta Valley, where its zone position appears to be Upper Sonoran. Shasta Valley is one belt lower than the rest of the region about Shasta and contains a dilute tongue of Upper Sonoran species that come in from the north by way of Klamath River Valley.

Alnus sinuata (Regel) Rydb. Alder.

Common in moist places in the canyons of the Canadian zone. In Mud Creek Canyon noted as high as 6,700 feet. Found also near Wagon Camp. (Identified by F. V. Coville.)

Alnus tenuifolia Nutt. Paperleaf Alder.

[=*A. incana* var. *virescens* Wats].

A Transition zone species common along streams in the neighborhood of Sisson Tavern and along the east base of Scott Mountains. (Identified by F. V. Coville.)

Betula occidentalis Hooker. Birch.

Fairly common along Shasta River at the south end of Shasta Valley. Not observed elsewhere.

Corylus rostrata californica A. DC.

Fairly common in the Transition zone in Squaw Creek Valley near McCloud Mill, and probably elsewhere at the base of the mountain.

Castanopsis sempervirens (Kellogg) Dudley. Sierra Chinquapin.

The distribution of the mountain chinquapin on Shasta is discontinuous. It is possible that two forms exist, one apparently restricted to the manzanita chaparral of the Transition zone from Sisson up to the lower edge of the Shasta fir belt; the other to the scattered stretches of *Pinus albicaulis* of the Hudsonian zone, where it reaches timberline on the rocky slopes and ridges.

Prof. William R. Dudley, of Stanford University, California, has, at my request, kindly looked up the proper name for the boreal Sierra chinquapin, which he finds to be *sempervirens* of Kellogg.¹ The type locality of *sempervirens* is the west slope of the Sierra near Mariposa. I have found the species abundant on a ridge near a stage station called Chinquapin, between Mariposa and the Yosemite, where it occurs with *Pinus jeffreyi*, *P. lambertiana*, *Abies magnifica*, *Pseudotsuga mucronata*, and *Prunus emarginata* at and above an altitude of 6,200 feet. The locality, therefore, is along the overlapping borderland between the Transition and Canadian zones.

Professor Dudley tells me that the 'var. *minor*' Bentham is the small southern coast range form of the true coast chinquapin, *Castanopsis chrysophylla*, and that the type locality is the Santa Cruz Mountains. *C. chrysophylla* is a handsome tree 75 to 125 feet in height, with large leaves, ending in long, slender attenuate points; *C. sempervirens* is a bush with small and relatively bluntly rounded leaves. I found both species common on the Trinity Mountains: *C. chrysophylla* on the sunny lower slopes in the Transition zone; *C. sempervirens* on the cold summit in the lower edge of the Canadian zone, where it is associated with *Arctostaphylos nevadensis*, *Cerasus emarginata*, *Ceanothus velutinus*, the dwarf mountain form of *Quercus chrysolepis*, and the very distinct *Q. vaccinifolia*.²

¹ Proc. Calif. Acad. Sci., I, p. 75, 1855 (reprint).

² *Quercus vaccinifolia* Kellogg is another excellent species, usually confounded with the dwarf mountain form of *Q. chrysolepis*, with which it has nothing to do. Their zone relations are much the same as those of the two species of *Castanopsis*, for *Q. vaccinifolia* occurs along the lower edge of the Boreal, and ranges up through the Canadian zone, always in rocky places, while *Q. chrysolepis* belongs to the Transition zone. Their ranges join where these zones meet, and I have found both growing side by side on the Trinity Mountains, and also on the Sierra. *Quercus chrysolepis* is a Transition zone tree which at the upper limit of its range is always dwarfed and often reduced to a shrub; but irrespective of size it always retains its characteristic leaves and acorn cups. *Quercus vaccinifolia* is always a small bush—rarely much over a meter in height—and, whether in fruit or not, is distinguishable at a glance by the character of its leaves and cups. The leaves are smaller, narrower, thinner, and blunter (commonly narrowly oval with an obtuse point instead of sharply lanceolate) and lack the yellow tomentum underneath; furthermore, their margins, although somewhat thickened, are not distinctly revolute. The acorn cups are smaller and thinner, and lack the beautiful yellow 'turban' so characteristic of *chrysolepis*; the acorns average shorter and thicker and the basal scar is smaller. The branchlets are much more slender, and glabrous or nearly so, instead of tomentose.

It is remarkable that a shrub of such wide distribution, and one differing so conspicuously from the tree chinquapin (*Castanopsis chrysophylla*), should so long escape recognition as a distinct species.

***Quercus californica* (Torr.) Cooper. Black Oak.**

[—*Q. kelloggi* Newb.]

The only oak of Shasta, where it is confined to the basal slopes of the Transition zone, reaching up on the south and west sides to an altitude of 4,500 feet. It is fairly common in McCloud Valley, more common at Sisson, and increases in abundance to the northward. Between Black Butte and Edgewood it is mixed with ponderosa pines and is one of the most conspicuous trees. It does not attain such large size in this region as nearer the coast and farther south in the Sierra.

[*Quercus garryana* was not found immediately about Shasta, and *Quercus wislizeni*, which pushes up the canyon of the Sacramento a long distance, does not fairly enter the region.]

***Asarum hartwegi* Watson. Wild Ginger.**

Occurs here and there throughout the Transition zone, but is commonest in damp places on the lower slopes. It does not reach quite up to Wagon Camp, but in a warm lava basin on the west side of the mountain was found at an altitude a little higher than Wagon Camp.

***Eriogonum marifolium* T. & G. Yellow Eriogonum.**

Common at Wagon Camp and other points along the lower edge of the Canadian zone and in the upper part of the Transition. The species seems to belong to the Transition rather than the Canadian zone, and Shasta is its type locality. (Identified by J. K. Small.)

***Eriogonum polypodum* Small. Small-leaf Alpine Eriogonum.**

The commonest and most widely distributed *Eriogonum* of the higher slopes, where it ranges from the lower edge of the Hudsonian zone up to and far above timberline. The highest altitude at which it was obtained is 10,000 feet. Its leaves are small and densely covered with a white woolly or hairy material, and its tortuous prostrate branches are so intertwined as to form little mats several inches in diameter on the stony pumice slopes; these whitish mats are vastly more compact and dense above timberline than below. The roots are strong but rather slender, and, like those of many other plants that live on the barren, wind-swept pumice slopes, are of extreme length. The main root usually slopes obliquely for 80 or 90 millimeters, and then divides into four or five slender rootlets 900 to 1,000 millimeters in length. The whitish tomentose leaves rarely rise more than 25 or 30 millimeters above the ground; the fruit stems 100 to 150 millimeters.

This plant and *Polygonum shastense* are probably the most abundant, conspicuous, and widespread plants of the Hudsonian and Alpine zones. They thrive in very dry soils and therefore are not confined

to the moist basins and strips bordering the streams, as are *Phyllodoce*, *Lutkea*, and many others. (Identified by J. K. Small.)

Eriogonum pyrolæfolium Hooker. Large-leaf Alpine Eriogonum.

Abundant on the pumice slopes of the Hudsonian and Arctic-Alpine zones, where it is associated with the foregoing species and with *Polygonum shastense*, *P. newberryi*, *Pentstemon davidsoni*, and others. It is easily recognized by its large roundish deep-green leaves, in striking contrast to the much smaller whitish-tomentose leaves of its congener and associate, *Eriogonum polypodum*. Both species are common all the way around the mountain. The present species (*pyrolæfolium*) is rarely found above an altitude of 9,500 feet, but on a warm slope east of Mud Creek Canyon Vernon Bailey found it as high as 10,000 feet. It flowered the second time above the head of Squaw Creek the latter part of September and was then in flower and fruit simultaneously. Its root is large, thick, tapering, and moderately strong; it subdivides into about half a dozen rootlets which penetrate so deeply into the soil that it is difficult to obtain specimens without breaking them. The longest root measured was 750 millimeters to the broken end. The leaves reach about 30 millimeters above the ground; the fruit stems 70 millimeters. The old imbricating leaf stems remain attached for several years and form a series of scales around the upper part of the perennial rootstalk.

Eriogonum nudum Dougl. Naked-stem Eriogonum.

Common in the lower part of the Transition zone, particularly about Sisson, where it was flowering plentifully as late as the end of September. It is easily recognized by its tall, green naked stems, which rise from a bunch of large tomentose leaves.

Oxyria digyna (Linn.) Alpine Sorrel.

One of the characteristic alpine species, growing in cold spots among the rocks at high altitudes on all sides of the mountain; found by Vernon Bailey as high as 11,200 feet. On the north side of Shastina we collected it at 8,900 feet, and on the northeast side of Red Butte as low as 7,600 feet. This is the lowest station at which it was found, and since *Pinus albicaulis* occurs above Red Butte the locality might be mistaken to be below timberline, but the sorrel grows only among the rocks on the cold northeast slopes, where there are no trees and where the temperature is truly alpine.

Polygonum shastense Brewer. Shasta Polygonum.

One of the commonest and most characteristic plants of the stony pumice slopes of the Hudsonian and Alpine zones. A singular and attractive plant, particularly in September, when it is heavily laden with white and red flowers and fruit. As a rule the flowers are whitish, turning red as the fruit begins to develop. No two plants could well be more different in general appearance than this species and its congener and

associate *Polygonum newberryi*, and few species bear a closer resemblance than *P. shastense* and its geographically remote relative *P. paronychia*. The resemblance is not only most striking, but is exceedingly interesting from the standpoint of geographic distribution. *Polygonum shastense* lives at high altitudes in the High Sierra and Cascade Range, while *P. paronychia* inhabits the outer sea beach in northern California and Oregon, where it is bathed in the chilly fogs of the Pacific Ocean. The root of *Polygonum shastense* is of moderate size and slopes very obliquely into the soil. It divides into half a dozen long slender rootlets, which penetrate to a depth of 550 millimeters or more. One specimen examined divided into three main roots of rather large size, which tapered very gradually and reached a length of 750 millimeters. The branches are prostrate and usually form loosely intertwined mats 300 to 500 millimeters in diameter, rising in some cases 40 to 50 millimeters above the surface, but usually flattened on the ground.

***Polygonum newberryi* Small.** Broad-leaf Polygonum.

Abundant from the lower edge of the Hudsonian zone up to a little above timberline, where its big green leaves are very conspicuous on the pale pumice soil and among the broken fragments of gray lava rock. About the middle of September the leaves turn red—often a deep handsome red—and begin to fall, so that by the end of the month the plant has practically disappeared. Its buckwheat-like fruit is a favorite food of the mice inhabiting the higher slopes.

***Oreobroma triphylla* (Wats.) Howell.** Dwarf Alpine Spring Beauty.

This tiny inconspicuous plant was found near timberline north and northwest of Red Butte. (Identified by Professor Greene.)

***Spraguea umbellata* Torr.** Pussy-paws.

Abundant on the pumice slopes of the Hudsonian zone, beyond which it pushes both upward and downward on suitable soils. The highest altitude at which it was noted is 9,400 feet on the east side of Mud Creek Canyon, but it was rarely seen above 9,000 feet. On the other hand, a form of it descends in suitable spots to the lower edge of the Canadian zone near Wagon Camp (altitude 5,600 feet), and to the same altitude in the lower part of Mud Creek Canyon.

***Stellaria crispa* C. & S.**

Collected by Vernon Bailey and Miss Wilkins in Mud Creek Canyon near the junction of Clear Creek. (Identified by Professor Greene.)

***Sagina saginoides* (L.) Brit.**

Occurs above timberline; collected by Miss Wilkins.

***Silene grayi* Watson.** Hudsonian Catchfly.

Common in stony places and along streams below timberline in the Hudsonian zone. Found both in the stony pumice soil and in the heather beds. (Identified by Miss Eastwood and Dr. B. L. Robinson.)

Silene suksdorfii Robinson.¹ Alpine Catchfly.

An alpine species common in scattered tufts, which form small compact mats under the edges of rocks, well above timberline. Often mixed with *Erigeron compositus*. (Identified by Dr. B. L. Robinson.)

Aconitum columbianum Nutt. Monkshood.

Common in a marshy place in the Shasta fir forest at Wagon Camp, where its tall wands of handsome blue flowers were conspicuous in July and its fruit in September.

Aquilegia truncata Fisch. & Mey. Red Columbine.

Common near Wagon Camp, in the upper part of the Transition zone. (Identified by Professor Greene.)

Delphinium sonnei Greene. Larkspur.

Common in moist spots in the Shasta fir forest near Wagon Camp, and also in the canyon of Ash Creek. (Identified by Professor Greene.)

Pæonia browni Dougl. Wild Pæony.

Occurs sparingly in the upper part of the ponderosa pine forest (Transition zone), particularly in the neighborhood of Wagon Camp.

Pulsatilla occidentalis Watson.

Common in places on the higher slopes (Hudsonian zone), particularly where the snow lies late. It blooms as the snow recedes, leaving a handsome globular head of feathery plumes which waves in the breeze long after the season of flowering.

Bikukulla uniflora (Kellogg) Howell.

Reported by Miss Eastwood from above timberline on Horse Camp Trail; not found by us.

Arabis platysperma Gray. Flat-pod Arabis.

The commonest and most widely distributed crucifer of the higher slopes of Shasta, where it occurs on stony slopes and along the edges of the heather beds from the lower edge of the Hudsonian zone upward on warm slopes to 10,200 feet. Its extreme vertical range appears to be about 3,000 feet. (Identified by Miss Eastwood.)

Cardamine bellidifolia pachyphylla Coville.

This small alpine crucifer, with white flowers and rather broad dark green leaves, is nowhere abundant, but was observed here and there above timberline, both on the main peak of Shasta and on Shastina. (Identified by F. V. Coville.)

Cheiranthus perennis (Coville) Greene. [= *Erysimum asperum perenne* Coville.]

Vernon Bailey and I found this coarse yellow-flowered crucifer at timberline on the north slope of Shastina July 24, but did not observe it elsewhere. (Identified by Professor Greene.)

¹ Botanical Gazette, vol. 16, p. 41, pl. 6, 1891.

***Draba breweri* Wats.** Sierra Alpine *Draba*.

Collected east of Mud Creek Canyon at an altitude of 13,000 feet by Miss Wilkins; not observed elsewhere. This *Draba* and *Polemonium pulchellum* are the only plants found at so great an elevation. (Identified by F. V. Coville.)

***Streptanthus orbiculatus* Greene.**

A Hudsonian species common on pumice soil in stony places at and below timberline all the way around the mountain. The plant is easily recognized by its long curved slender pods and its rather large domed leaves. The length of the large tapering root only slightly exceeds the height of the plant. (Identified by Professor Greene.)

***Chrysamphora californica* (Torr.) Greene.** California Pitcher Plant.
(= *Darlingtonia* Auct.)

This interesting pitcher plant is exceedingly local in distribution. Mr. Elmer Applegate tells me that it is common in the upper part of the Sacramento Canyon, a short distance from Sisson Tavern. It has been reported as occurring in the 'marshes' of Shasta, but we did not find it on the mountain, nor did we find any marshy areas more than a few rods in extent.

***Drosera rotundifolia* Linn.** Sundew.

Collected by Miss Wilkins in the springy bog just above Wagon Camp in the Canadian zone. Not observed elsewhere.

***Mitella pentandra* Hook.**

Common in the heather patches along the overhanging banks of streams in the Hudsonian zone. Abundant at Squaw Creek Camp. (Identified by Professor Greene.)

***Parnassia californica* (Gray) Greene.** Grass-of-Parnassus.

This elegant flower is common along the water courses of the Hudsonian zone, usually growing along the overhanging banks of the tiny rivulets. It blossoms late, and a few plants were still in flower when snow fell, the last week in September.

***Saxifraga bryophora* Gray.**

Reported by Miss Eastwood from the timberline region on Horse Camp Trail; not found by us.

***Saxifraga tolmiei*¹ T. & G.** Alpine Rock Saxifrage.

Common above timberline, where it usually forms small dense mats in moist places among rocks. On Inconstance Creek, on the north side of Shasta, it was found as low as 7,600 feet. On the south slope it ranges up to 11,000 feet, or possibly higher. On the cold northeast side of Red Butte it occurs among the rocks with *Oxyria digyna*. (See p. 50.)

¹ The spelling *tolmai* should be regarded as an obvious typographical error.

Peltiphyllum peltatum (Torr.) Engler. Giant Water Saxifrage.

One of the most conspicuous plants in the bottom of the Sacramento Canyon, where its clusters of huge incised roundish leaves along the water's edge suggest the devil's club. It ranges along the Sacramento River from just below Sisson nearly to the Sacramento Valley.

Ribes amictum Greene.

Occurs at Wagon Camp, along Squaw Creek, and in the bottom of Mud Creek Canyon at an altitude of 6,700 feet. (Identified by Professor Greene.)

Ribes cereum Dougl.

Found near timberline near the head of Panther Creek, and also much lower down.

Ribes viscosissimum Pursh.

Common near Wagon Camp and observed at other points within the Transition zone, particularly along Squaw Creek.

Ribes klamathense Coville.

Occurs in cool moist places in the Transition zone at Sisson. (Identified by F. V. Coville.)

Cercocarpus ledifolius Nutt. Mountain Mahogany.

Common on Sheep Rock and thence to the southeastern corner of Shasta Valley (V. Bailey), and on warm, dry slopes of the Scott Mountains, where *C. parvifolius* also occurs.

Fragaria bracteata Heller. Small Strawberry.

Common on the lower slopes. Just below Wagon Camp strawberries and painted cups are so abundant as to form an almost continuous carpet under the uppermost grove of ponderosa pines. (Identified provisionally by P. A. Rydberg.)

Fragaria chiloensis Duchesne. Large Strawberry.

Occurs with the last a little below Wagon Camp, but is much commoner lower down, particularly near Sisson. Sisson Tavern was formerly called 'Berryvale' and is located in 'Strawberry' Valley. Both names were derived from the abundance of this wild fruit there in early days. (Identified provisionally by P. A. Rydberg.)

Holodiscus discolor (Pursh) Maxim. Alpine Spiraea.

Common on rocks at and a little below timberline, usually associated with *Pinus albicanlis*. It is a small, fragrant bush, usually less than a foot in height, and always grows among rocks at high altitudes. In the Hudsonian zone it was found all the way around the mountain, and was in blossom from about July 20 until September. A larger form, which the botanists do not appear to have named, occurs lower down, in the Canadian zone. It has larger, broader, and thinner leaves and should be separated.

Spiræa douglasi Hook. Red Spiræa.

Common in moist places in the Canadian and Transition zones, but most abundant in the latter. It is common at Sisson, at the west base of the mountain, and in Squaw Creek Valley on the south side, and thence upward, in suitable moist spots, to Wagon Camp at 5,700 feet, along Squaw Creek at 6,000 feet, and in Mud Creek Canyon as high as 6,700 feet.

Horkelia pseudocapitata Rydberg.

Abundant in the Transition zone near Wagon Camp, particularly about the upper limit of *Pinus ponderosa*. (Identified by P. A. Rydberg.)

Kunzia tridentata (Pursh.) Spreng.

Irregularly distributed in the Transition zone; commonest in the manzanita chaparral of the lower slopes. On the north side of the mountain it is exceedingly abundant, and in the open pine forest bordering the south end of Shasta Valley attains unusually large size. On the west side, north of Sisson, it occurs sparingly on most of the warmer and drier knolls, and more plentifully between Black Butte and Shasta Valley. It is almost always associated with *Arctostaphylos patula*, with which it ascends some of the warmer slopes to points far above the upper limit of its usual distribution. Thus it was found on a southwest slope in Mud Creek Canyon between the altitudes of 6,700 and 7,400 feet; on similar slopes near Horse Trail and in Diller Canyon as high as 7,800 to 7,900 feet, and on a warm pumice ridge north of Shastina at 7,500 feet.¹ In Squaw Creek Valley, near McCloud Mill, a form occurs which has exceedingly narrow leaves.

Lutkea pectinata (Hook.) Kuntze.

Abundant in the Hudsonian zone, chiefly in the neighborhood of timberline, where it is common along the little streams in the upper edge of the forest, and in the glacial basins which are wet from melting snows in the early part of the season, but may be dry at the time the plant blossoms. In damp spots, particularly along the borders of cool springs, the individual plants often stand so near together as to form extensive beds.

Potentilla flabellifolia Hook.

Occurs here and there, a little below timberline, in the Hudsonian zone. (Identified by Miss Eastwood and P. A. Rydberg.)

Potentilla pseudorupestris Rydberg. Dwarf Alpine Potentilla.

A dwarf Alpine or high Hudsonian *Potentilla* of the *glandulosa* type, collected on the north side of Shastina at an altitude of about 8,800 feet, is provisionally referred to this species by Mr. Rydberg.

¹ For an explanation of this seemingly abnormal range, see p. 49.

Potentilla glandulosa Lindl. Large Yellow Potentilla.

A large *Potentilla* from the Transition zone, near Wagon Camp, is identified by Mr. Rydberg as *P. glandulosa*.

Rosa californica C. & S. California Rose.

Abundant in moist places in the Transition zone near Sisson Tavern and along the east base of Mount Eddy.

Rosa gymnocarpa Nutt. Wild Rose.

Common in places in the Transition zone, particularly a little below Wagon Camp.

Rubus parviflorus Nutt. [= *R. nutkanus* Auct.] Western Thimbleberry.

Common in cool moist places in McCloud Valley and at Sisson, and thence up through the Transition zone to an altitude of 5,200 feet on the road to Wagon Camp, and 6,000 feet along Squaw Creek and in Mud Creek Canyon. Most of the Transition slopes of Shasta are too dry for the thimbleberry.

Rubus vitifolius C. & S. Blackberry.

Common in cool moist places in the Transition zone near Sisson and along the east base of the Scott Mountains.

Sibbaldia procumbens Linn. Alpine Sibbaldia.

Common in the Hudsonian zone near timberline, particularly in springy places and in the heather beds. Usually occurs in small patches below extreme timberline.

Amelanchier alnifolia Nutt. Serviceberry.

Abundant in moderately moist parts of the Transition zone. On the west and southwest sides of the mountain it reaches from Sisson to Wagon Camp. On a warm southwest slope on the steep ridge between Mud Creek Canyon and Clear Creek it occurs, with several other Transition zone species, at the unusual altitude of about 7,000 feet. (See p. 49.)

Crataegus rivularis Nutt. Black Haw.

Common in the Transition zone about the west base of Shasta, particularly along streams at the east base of Mount Eddy, from the head of the Sacramento northward, usually in cool moist soil. Common near Sisson Tavern.

Sorbus sambucifolia (C. & S.). Mountain Ash.

Rather scarce and confined chiefly to the relatively moist Transition zone slopes of the canyons. In Mud Creek Canyon it was found along the bottom from 5,600 feet to 6,700 feet. Along Squaw Creek it was found at about 5,500 feet.

Cerasus demissa (Nutt.). Western Chokecherry.

Common in places in the lower part of the Transition zone. Observed on the south slope above McCloud Mill, mainly in the gulches; also in the neighborhood of Sisson, and near the south end of Shasta Valley.

Cerasus emarginata Dougl. Bush Cherry; Bitter Red Cherry.

Abundant in places in the chaparral of the Transition zone. In Sacramento Canyon, south of Shasta, it begins at 'The Loop,'¹ and ranges up to the lower edge of the Canadian zone. It is profusely abundant at Wagon Camp, where it is a straggling bush a little higher than a man's head, and usually grows in thickets. It ascends Mud Creek Canyon to an altitude of 5,600 or 5,700 feet.

Cerasus glandulosa Kellogg.

A sapling or small tree having large broad leaves; collected by me a short distance south of Sisson Tavern. (Identified by Professor Greene.)

Prunus subcordata Benth. Wild Plum.

Common in places along the southern and western borders of Shasta Valley, usually in the edge of the open *Pinus ponderosa* forest and often growing with *Rhus* and *Kunzia*. We found it also near Etna, on the west side of Scott Valley.

Cercis occidentalis Torr. Red-bud.

Reported from Mount Shasta in the Botany of California, but not found by us except in the Sacramento Canyon, where it is common.

Lotus americanus (Nutt.) Bisch. [= *Hosackia americana*.]

Common in the Transition zone at Wagon Camp, and thence along the road to Sisson, growing chiefly in open places in the chaparral.

Lupinus elmeri Greene [= *L. albicaulis sylvestris* Auct.]

Common in places throughout the upper part of the Transition zone, and ranging into the Canadian. Common at Wagon Camp and a little above. Found also in Mud Creek Canyon at mouth of Clear Creek. (Identified by J. B. Leiberg.)

Lupinus 'ornatus' Auct. [not of Douglas.] Silvery Lupine.

This beautiful species is common in spots near and a little below timberline, sometimes covering extensive areas, but not uniformly distributed. Where it occurs it is usually sufficiently abundant to give the mountain side the effect of a distinct silvery covering. It always grows on stony or pumice slopes and usually among or near white bark pines, although in a few instances it was found outside of the pine areas. It is common near the head of Squaw Creek and on both sides of Mud Creek Canyon. On the east side of this canyon it is particularly abundant just above the trees, and stops abruptly at an altitude of 8,200 to 8,400 feet, to be replaced by the dwarf Alpine *L. lyalli*. On the north side of Shasta it is common in an open forest of white-bark

¹In this and subsequent references to 'The Loop' the statement means that in going north along the railroad track we first saw the plant at 'The Loop.' The species may occur farther south in the canyon on suitable slopes above the level of the railroad.

pinus in a shallow gulch at the east base of the lava buttes just below 'North Gate.' The upper limit of the silvery lupine usually coincides with the lower limit of the dwarf lupine (*L. lyalli*), which species generally pushes from this point upward through the Alpine zone.

The root of the silvery lupine is slender and tough, and soon divides into two or three very long wire-like rootlets which run a rather shallow course in the sand. Some of them measure 750 millimeters. The plant at timberline averages about 60 millimeters in height.

Mr. Leiberg tells me that this species, although commonly referred to '*ornatus*', is not *ornatus* of Douglas. It has also been called *L. argenteus decumbens* Watson.

Lupinus albifrons Benth.

Collected near Horse Camp August 20 by Vernon Bailey and Miss Wilkins. (Identified by J. B. Leiberg.)

Lupinus lyalli Gray. Dwarf Alpine Lupine.

Abundant and widely distributed over the higher rocky pumice slopes from timberline or a little above up to an altitude of slightly more than 10,000 feet. (Identified by J. B. Leiberg.)

Lupinus minimus Dougl. Dwarf Lowland Lupine.

Common in the Transition zone at Sisson. (Identified by J. B. Leiberg.)

Vicia americana Muhl.

Rather common at and below Wagon Camp, and still in flower when we left, September 25.

Linum lewisii Pursh. Wild Hemp.

Abundant at Wagon Camp, where its delicate blue flowers were conspicuous in July, and its large subglobular seed capsules in September.

Polygala cornuta Kellogg.

Occurs plentifully in the dry pine woods of the Transition zone near Sisson Tavern, but was not observed on the mountain proper. (Identified by Miss Eastwood.)

Rhus trilobata Nutt.

In going north from Sisson we first observed this species a mile or two south of Edgewood, to the north and east of which it became more and more common. Its zone position here is along the borderland between the Transition and Upper Sonoran zones.

Pachystima myrsinites Raf. Oregon Boxwood.

Common in the Transition zone at the west base of Shasta, from Sisson up to an altitude of about 4,700 feet, usually in manzanita chaparral. Its absence from the higher slopes within the proper zone limits of the species is probably due to heat and dryness, as explained elsewhere (p. 56), but it is possible that the Sisson plant is a Transition zone subspecies of the true Boreal *P. myrsinites*.

Acer macrophyllum Pursh. Oregon Maple; Big-leaf Maple.

The tree maple is rare in the region about Shasta, where it was observed only in moist places in the lower part of the Transition zone near Sisson and in the upper part of the Sacramento Canyon.

Acer glabrum Torr. Bush Maple.

Fairly common in McCloud Valley and in moist places along streams and canyons in the Transition zone. In Mud Creek Canyon it was found up to an altitude a little above 5,600 feet, and along Squaw Creek to nearly 6,000 feet.

Acer circinatum Pursh. Vine Maple.

This characteristic west-coast species, with nearly circular 7-point leaves, occurs sparingly in moist places near Sisson Tavern, but is not common. It is one of the most distinctive plants of the humid Pacific coast division of the Transition zone.

Ceanothus cordulatus Kellogg. Snow Bush.

Common in the lower part of the Transition zone on the southern and western basal slopes of Shasta. In the upper part of Sacramento Canyon it first occurs at 'The Loop,' whence it is abundant northerly to within a mile or two of Edgewood. At Sisson and in Squaw Creek and McCloud valleys it is very abundant, but for some reason not apparent it does not reach on Shasta its usual upper limit, and was not observed anywhere above 4,900 feet. Possibly it is choked out by the other chaparral, which is made up mainly of manzanita (*Arctostaphylos patula*) and buck-brush (*Ceanothus velutinus*).

Ceanothus cuneatus Nutt. Wedge-leaf Ceanothus.

This is one of the most characteristic shrubs of the Upper Sonoran zone in California, where it is generally associated with the curious digger pines. The region about Shasta is too high for it. It occurs, however, in the lower valleys, both north and south of Sisson. On the north it reaches from Yreka to a little beyond Edgewood, appearing a mile or two south of the latter point on the road to Sisson, and about 4 miles southwest of it on a road farther west. Skipping the broad Transition belt between Edgewood and the Sacramento, it occurs next at Delta, in the Sacramento Canyon, and ranges thence southerly. Its upper border meets the lower border of another species, *C. cordulatus*, which is common at Sisson, as well as on the southern and western basal slopes of Shasta.

Ceanothus velutinus Dougl. Buck-brush.

Profusely abundant on all the manzanita-covered slopes of Shasta, from the lower part of the Canadian zone down nearly to the lower edge of the Transition. Mixed with *Arctostaphylos patula* in nearly equal proportion it forms the dominant chaparral of the mountain.

Tongues of it push up on warm southerly slopes to about 6,600 feet¹ altitude, and it descends on the west slope to about 4,200 feet (half a mile east of Sisson), and on the south slope to 3,600 feet (near McCloud Mill). Along the east base of Mount Eddy, where it is sheltered from the afternoon sun, it appears about 2 miles north of Sisson (altitude 3,700 feet), and continues northerly for many miles.

Ceanothus integerrimus H. & A. California Lilac.

Common in parts of the Transition zone, notably in Squaw Creek Valley near McCloud Mill, and in the upper Sacramento Valley a little below Sisson, but very scarce or absent on the slopes of Shasta proper. Like *C. cordulatus* it seems to be kept out by some unknown cause, possibly choked out by other species. Perhaps the soil is too dry for it.

Ceanothus (Cerastes) prostratus Benth. Squaw Carpet.

In following the Sacramento Canyon northward, Squaw Carpet was first seen at the 'The Loop,' a few miles south of Sisson, whence it occurs in greater or less abundance throughout the ponderosa pine forest and manzanita chaparral to the lower slopes of Shasta, where on the southwest side it reaches up to 5,200 feet.

Rhamnus californica Esch. (This form may be *R. rubra* Greene.)

Scarce and confined to low altitudes in the Transition zone. Found by Vernon Bailey in Squaw Creek Valley below 4,000 feet. Specimen lost.

Hypericum anagalloides C. & S. Dwarf Hypericum.

Common in spots in wet places in the Hudsonian and Canadian zones. It was most common in the second meadow on Squaw Creek, and by no means rare near Wagon Camp, and was in flower in late July and throughout August.

Viola blanda Willd. White Violet.

Collected by Miss Wilkins in the middle meadow on Squaw Creek, at an altitude of 7,500 feet. Not observed elsewhere.

Viola purpurea Kellogg. Alpine Yellow Violet.

Common on dry rocky slopes on pumice soil from some distance below timberline upward, on warm southerly exposures, to 9,300 feet. When we reached the mountain, the middle of July, its yellow flowers were conspicuous, although even at that time the species had nearly passed flowering. Its fruit and dark green leaves remained as late as the latter part of September, sharply outlined against the whitish stones and pumice of the bleak and barren upper slopes, where a violet seemed singularly out of place. (Identified by Miss Eastwood and Professor Greene.)

¹ For its extreme upper limit, on hot canyon slopes, see remarks under *Arctostaphylos patula*, p. 158.

Mentzelia lævicaulis (Dougl.) T. & G.

Rather common in Shasta Valley, but not found elsewhere about the mountain. This species seems to belong to the Upper Sonoran zone, and therefore has no place in the flora of Mount Shasta.

Epilobium spicatum Lamarek. Willow Herb; Fire-weed.

Abundant in places, chiefly on old burns in the Canadian and Transition zones. At Wagon Camp it did not begin to flower until near the middle of August; at Sisson it was still in flower in places as late as the middle of September.

Epilobium brevistylum Barbey.

Collected at Wagon Camp, where it is tolerably common in moist places; the largest species next to *spicatum*. (Identified by Professor Trelease.)

Epilobium oregonense Hausskn.

Common at Wagon Camp. A large form occurring also at Wagon Camp Professor Trelease considers as probably *E. glaberrimum* Barbey.

?Epilobium hornemanni Reichenb.

Some poor specimens, with exceedingly long seed capsules, collected by me a little below timberline about the end of the season, are doubtfully referred to this species by Professor Trelease.

Epilobium clavatum Trelease.

Abundant in the heather meadows and along the edges of the cool streams of the Hudsonian zone at and a little below timberline. (Identified by Professor Trelease.)

Epilobium pringleanum Hausskn.

A tiny alpine species, rarely as tall as one's thumb, occurring here and there on the borders of the highest streamlets above timberline. (Identified by Professor Trelease.)

Epilobium oboordatum Gray. Rose Epilobium.

Local—common near timberline on the steep west side (east slope) of Mud Creek Canyon. A remarkable plant, strikingly unlike the others of its genus. It has a woody base and is really a dwarf bush. Its large red flowers are showy and very handsome. (Identified by Miss Eastwood and Professor Trelease.)

Gayophytum ramosissimum T. & G.

Abundant throughout the Transition zone, where it was equally common at Sisson and at Wagon Camp and was in flower as late as the end of September. (Identified by Miss Eastwood.)

Carum gairdneri (Hook. & Arn.) Gray.

Rather common in damp soil at Wagon Camp where the Canadian and Transition zones meet. (Identified by Dr. J. N. Rose.)

***Cymopterus terebinthinus* T. & G.**

Common in the neighborhood of timberline, usually in stony places on dry pumice slopes; found also on top of Red Cone, a little east of Wagon Camp. This species has a large and woody root and a remarkably rank and lasting odor. Its zone position is Hudsonian; a larger unrecognized form occurs in the Canadian zone. (Identified by Miss Eastwood and Dr. Rose.)

***Ligusticum grayi* Coulter & Rose.**

Common throughout the Hudsonian zone, particularly a little below timberline, where it occurs most abundantly in the beds of heather along the little streams. In places it pushes down into the Canadian zone. (Identified by Miss Eastwood and Dr. Rose.)

***Heracleum lanatum* Michx. Cow Parsnip.**

Occurs in damp places in the Canadian zone. In Mud Creek Canyon near the mouth of Clear Creek it was found as high as 6,700 feet. (Identified by Dr. Rose.)

***Osmorrhiza nuda* Torr.**

Found sparingly at Wagon Camp and at Sisson.

***Cornus nuttalli* Audubon. Oregon Dogwood.**

Rather common in moist places in the lower half of the Transition zone. It occurs in Squaw Creek Valley near McCloud Mill, and is common along the streams near Sisson Tavern; on the road from Wagon Camp to Sisson it was seen up to an altitude of 4,500 feet.

***Cornus pubescens* Nutt.**

Common in cool damp soil near Sisson and along the upper Sacramento.

***Chimaphila umbellata* (L.) Nutt.**

Occurs here and there throughout the drier parts of the forest, but is less common than *Chimaphila menziesi*.

***Chimaphila menziesi* Spreng.**

Fairly common throughout the Shasta fir forest, and also in the mixed forest of pines and firs from the upper Sacramento Canyon northward (Canadian and Transition).

***Pyrola picta* Smith.**

Occurs here and there throughout the forest of Shasta firs, where its ornamental light-marbled leaves are pleasingly conspicuous against the dark soil.

***Pyrola pallida* Greene.¹**

Found sparingly on the dry summit of Red Cone, about a mile east of Wagon Camp. (Identified by Professor Greene.)

¹ Pittonia, IV, p. 39, March 17, 1899.

***Pyrola secunda* Linn.**

Decidedly less common than *P. picta*, but like it found in the Shasta fir forest.

***Pterospora andromedæ* Nutt. Pinedrops**

Found in the dry woods along the border between the Canadian and Transition zones. (Identified by Professor Greene.)

***Pleuricospora fimbriolata* Gray.**

Collected at Wagon Camp by Miss Wilkins. (Identified by F. V. Coville.)

***Sarcodes sanguinea* Torr. Snow Plant.**

This handsome plant is reported as common on the forested slopes of Shasta at the time of melting snow in spring. It probably occurs in both the Canadian and Transition zones.

***Arctostaphylos nevadensis* Gray. Dwarf Mountain Manzanita.**

Common in the Canadian and Hudsonian zones, growing in extensive beds a foot or less in height. On the high ridges, among the timber-line *Pinus albicaulis*, these beds of green cover the pale gray lava rocks, and in the dark forests of Shasta fir they form the only conspicuous surface vegetation.

***Arctostaphylos patula* Greene. Green Manzanita.**

The most abundant and troublesome chaparral of Shasta. It is a characteristic Transition zone species and covers the lower slopes all the way around the mountain except a belt about 10 miles wide on the



FIG. 45.—Manzanita chaparral.

northeast base, reaching from Ash Creek to about 3 miles northwest of Inconstance Creek, which is too cold for it and is occupied by Canadian zone species. On the north, west, and south it covers practically the whole of a broad belt several miles in width, reaching from base level

to the lower edge of the Canadian zone and formerly occupied in the main by a forest of ponderosa pines, some of which still remain scattered over it. Except at its extreme lower limit, it is usually mixed with buck-brush (*Ceanothus velutinus*).

Seen from a distance, the extensive areas of manzanita on the lower slopes of Shasta are very deceptive. They look like meadows of green grass, but to cross them is in most cases impossible, owing to the density of the growth and rigidity of the branches. For this reason they form secure retreats for black bears, deer, wild-cats and other animals.

At two places on the west side of the mountain *Arctostaphylos patula* reaches the extraordinary altitude of 7,800 to 7,900 feet. One of these is on the north side of Diller Canyon, the other on the north side of Horse Camp Trail. Both stations are on long and steep southwest pumice slopes which receive the hot rays of the afternoon sun almost at a right angle, carrying up numerous Transition zone species nearly 2,000 feet above their normal limit. (See p. 51.) From the southwest base of Shasta the green manzanita reaches down the canyon of the Sacramento River to 'The Loop.'

Phyllodoce empetrifomis (Gray). Red Heather.

[=*Bryanthus empetrifomis* Auct.]

Abundant along the cold streams of the Hudsonian zone and in the bottoms of the glacial basins that are kept moist by melting snows; commonest between the altitudes of 7,500 and 8,500 feet, and not seen above 9,100 feet. This is the only 'heather' found on Shasta. It usually forms extensive beds or carpets in which numerous other plants find a congenial home. These beds are practically the only flower gardens on the mountain, and the only areas where small plants are plentiful enough to give the effect of continuous green; hence they are commonly spoken of as 'heather meadows.'

Kalmia glauca microphylla Hook. Alpine Laurel.

Abundant in most of the heather meadows just below timberline, particularly along Squaw Creek. In general size and aspect the alpine laurel resembles the red heather so closely that at a little distance it is difficult to tell them apart.

Vaccinium cæspitosum Mich. Dwarf Alpine Blueberry.

Abundant on the higher slopes within the Hudsonian zone, reaching a little above timberline. Common here and there in the stony pumice flats and basins, but commonest near the streams, where it is scattered through the heather and forms beds of its own along the outer edges of the heather beds. Its leaves turn dark red or garnet during the latter half of September, contrasting handsomely with the dark green of the heather. In the neighborhood of timberline the dwarf blueberry is rarely more than three or four inches in height. It was in full bloom the middle of July.

The form here referred to is the dwarf High Sierra one, given under *caespitosum* by Coville, in his 'Botany of the Death Valley Expedition' (p. 145, 1893).

Vaccinium arbuscula (Gray) [= *Vaccinium caespitosum* var. *arbuscula* Gray].

Common in moist places in the Transition zone from Wagon Camp down to Warmcastle Soda Springs at the south base of the mountain. This species seems to be distinct from the dwarf boreal *V. caespitosum*. It averages about 2 feet (60 centimeters) in height and has red branches and decidedly larger and thicker leaves than the alpine *caespitosum*. Whether or not the latter is the typical form is another question. The zone position of *V. arbuscula* is probably Canadian and Transition.

Vaccinium occidentale Gray. Blueberry.

Common in the Canadian zone in some of the canyons, and in the marsh at Wagon Camp, where it fruited early.

Fraxinus oregana Nutt. Oregon Ash.

Occurs sparingly in the upper Sacramento Canyon, but was not observed about the actual base of the mountain.

Gentiana simplex Gray. Blue Gentian.

Common in the Canadian zone swamp at Wagon Camp the first half of August. (Identified by Professor Greene.)

Apocynum pumilum (Gray) Greene.

Common in suitable places throughout the Transition zone, from which it pushes up a short distance into the lower edge of the Canadian. With other Transition zone species it was found on a warm slope in Mud Creek Canyon at 6,700 feet. (Identified by Professor Greene.)

Cycladenia humilis Benth.

Common in places in the Hudsonian zone, but very local. It occurs plentifully on the top of Red Cone, a short distance northeast of Wagon Camp, at an elevation of about 6,600 feet; on a red lapilli hill which forms a part of Red Butte, just east of 'The [South] Gate,' and on both sides of Mud Creek Canyon a little below true timberline. The highest altitude at which it was observed was 8,700 feet on a southwesterly slope on the west side of Mud Creek Canyon. *Cycladenia humilis* is a curious and rather striking plant. It usually has four large entire leaves, suggesting those of *Polygonum newberryi*, and bears a pair of conspicuous red tubular flowers followed by two curious seed pods, which are very long and lie side by side, one above the other, like the barrels of a Winchester rifle. (Identified by Miss Eastwood.)

Gilia aggregata (Pursh) Spreng.

Common throughout the ponderosa pine forests of the Transition zone and sometimes seen in the lower part of the Shasta fir forest, where its

handsome scarlet flowers are very attractive. On warm southwest slopes near Panther Creek it was found as high as 6,600 feet, and between Mud and Clear creeks as high as 6,700 feet, but these are abnormal altitudes due to unusually warm exposures and soil.

Collomia grandiflora Dougl.

Common in the upper part of the Transition zone a little below Wagon Camp, where it was flowering abundantly the last half of July.

Phlox douglasi diffusa (Benth.) Gray. Alpine Phlox.

A common, widely distributed, and conspicuous plant of the higher slopes within the Hudsonian zone, sometimes straggling down into the Canadian zone. It occurs in scattered tufts on the dry rocky slopes and ridges, usually on pumice soil, and is commonest in the neighborhood of timberline. It blossoms early, and flowers were rarely seen as late as the latter part of July. After flowering the whole plant withers and is disintegrated by the wind, so that little more than the woody base remains.

Polemonium pulchellum Bunge.

A characteristic but not abundant Alpine species, occurring here and there among rocks far above timberline. On the north side of Shastina it was in full bloom July 24 at an altitude of 8,900 feet. On the south side of Shasta, above Squaw Creek, and on both sides of Mud Creek Canyon, it was not found below 9,500 feet, whence it ranges up to 13,000 feet. This species and *Draba breweri* were both observed at 13,000 feet, and are the highest plants found on Shasta. (Identified by Professor Greene.)

Phacelia frigida Greene.¹ Dwarf Alpine Phacelia.

This new species, which Professor Greene has kindly described at my request from specimens collected by us above the head of Squaw Creek, is common and widely distributed on the higher and more barren rocky slopes, beginning above timberline and reaching, on southerly slopes, as high at least as 10,200 feet. The lowest altitude at which it was found is 8,700 feet, on a cold slope.

Phacelia magellanica (Lam.) Coville.

A plant which, in the present unsatisfactory state of the group, it seems necessary to refer here, is abundant on the lower slopes, particularly in the Transition zone, where it was in flower throughout the summer and as late as the end of September.

Cryptanthus geminata Greene.

Rather common in the Transition zone below Wagon Camp. (Identified by Professor Greene.)

¹ Pittonia, IV, pp. 39-40, March 17, 1899.

***Lappula nervosa* (Kellogg) Greene.**

Abundant in the openings near and a little below Wagon Camp, where it is the most troublesome 'stick-tight' of the region, filling the forelocks and manes of the horses and binding them together in a dense mat.

***Monardella odoratissima* Benth.**

Abundant in the Canadian zone and much less common in the Hudsonian. Abundant in the chaparral at Wagon Camp and found in several places on warm sunny slopes as high as 7,800 or 7,900 feet, and in one place near the head of Squaw Creek at 8,300 feet. In the latter locality only a few bunches occur among the rocks and no others were observed for a long distance below.

***Scutellaria nana* Gray. Dwarf Skullcap.**

This interesting little yellow-flowered skullcap was found at one place only—the north slope of Shastina, at an altitude of 8,800 feet, where it was flowering July 24. If this alpine plant is the same as the type of *S. nana*, which came from the hot desert region near Pyramid Lake, Nevada, its occurrence at timberline on Shasta must be accidental. (Identified by F. V. Coville.)

***Stachys ingrata* Greene.**

Abundant in moist soil at Wagon Camp, on the border between the Canadian and Transition zones. (Identified by Professor Greene.)

***Chamæsaracha nana* Gray.**

This solanaceous plant, which has large white flowers and looks like a dwarf potato, is common in an old burn near Wagon Camp, where the Canadian and Transition zones overlap. (Identified by Miss Eastwood.)

***Castilleja miniata* Dougl. Scarlet Painted Cup.**

Common and conspicuous. A large form, probably the type form—since the type came from the Blue Mountains of Oregon—is common in moist places in the lower part of the Canadian zone and upper part of the Transition. It was flowering abundantly in the uppermost grove of ponderosa pines at Wagon Camp the latter half of July. A smaller form, apparently unnamed, abounds in the heather beds of the Hudsonian zone near and a little below timberline, where it was flowering profusely the first half of August.

The scarlet painted cup is one of the handsomest flowers of the mountain. Where the plants are abundant on the dark heather the effect of the bright green corolla tubes protruding in slender spindles from the vivid scarlet mass of bracts and calyx is superb. Early in August the calliope hummingbirds were constantly hovering over these flowers. (Identified by M. L. Fernald.)

Castilleja affinis Hook. & Arn.

A plant collected in the Hudsonian zone near timberline just north of Red Butte by Vernon Bailey has been identified as this species by M. L. Fernald. Since the type locality of *affinis* is the low coast strip near San Francisco or Monterey, the typical form would hardly be expected to occur in the high timberline region of Shasta.

Orthocarpus pilosus Watson.

Common in places near timberline, particularly near 'The [South] Gate,' between the heads of Panther Creek and Squaw Creek. (Identified by M. L. Fernald.)

Mimulus implexus Greene.

Abundant in wet places throughout the Hudsonian zone, reaching its greatest perfection in the neighborhood of timberline. In the shallow rapids of some of the mountain rivulets it grows in such profusion that its leaves form extensive mucilaginous patches, which completely fill the beds of the streams. Its large and showy yellow flowers were in blossom from the latter part of July until the end of September. (Identified by Professor Greene.)

Mimulus moniliformis Greene.

Two forms of large yellow *Mimulus* grow in the marsh at Wagon Camp, in the lower edge of the Canadian zone. (Identified by Professor Greene.)

Mimulus tilingi (Regel.) Greene.

Common in the marsh at Wagon Camp. (Identified by Professor Greene.)

Mimulus primuloides Benth.

Common in patches in marshy places and along streams in the Canadian and Hudsonian zones, but much more common in the Canadian than in the Hudsonian. It was abundant at Wagon Camp and also in some of the heather meadows along Squaw Creek and other streams. (Identified by Miss Eastwood and Professor Greene.)

Pentstemon menziesi Hook.

One of the most characteristic and widely distributed plants of the higher slopes, where it is common among the bare rocks all the way around the mountain. It is common in the Hudsonian zone in the neighborhood of timberline, but much more abundant in the Alpine, and was found by Vernon Bailey as high as 10,200 feet. This species is easily distinguished from the other Alpine species of the region by its smooth entire leaves and relatively small bluish or violet blue flowers, which become pink or reddish with age. (Identified by Professor Greene.) The plant is by no means typical, but seems to be intermediate between *menziesi* and *davidsoni*. It may be a distinct species.

***Pentstemon newberryi* Gray.**

Common in places in the Hudsonian zone and possibly in the upper part of the Canadian; much less generally distributed than *P. menziesi* and usually occurring at lower altitudes. On the north side of Shastina it was flowering, the latter part of July, at an elevation of 7,600 feet, and at the same time on the cold east slope of Mud Creek Canyon as low down as 5,600 feet. Its flowers are much larger than those of *P. menziesi* and red instead of bluish; its leaves are longer, and are serrate instead of entire.

***Pentstemon glaber utahensis* Watson.**

Abundant just below timberline on the curious *Pinus albicaulis* plain between North Gate and Bolam Creek, on the north side of Shasta, where it was flowering plentifully July 24. It was not seen elsewhere on the mountain. Its blue-purple flowers are even larger than those of *P. newberryi* and are very showy and handsome. (Identified by Professor Greene.)

***Pentstemon deustus* (Dougl.). Yellow Pentstemon.**

Common in the rough black lava beds in the Shasta fir forest north of Cascade Gulch, on the west side of the mountain, at an altitude of about 7,500 feet, but not seen elsewhere. This species is a dwarf bush 5 or 6 inches high, with yellow flowers and strongly serrate leaves. (Identified by Professor Greene.)

***Pentstemon gracilentus* Gray.**

Abundant in places in the Shasta fir forest, particularly between the canyons of Mud and Ash creeks, in the Canadian zone. (Identified by Miss Eastwood and Professor Greene.)

***Pentstemon confertus* Dougl. (Not typical.)**

Common near Wagon Camp. (Identified by Miss Eastwood and Professor Greene.)

***Veronica cusicki* Gray.**

Common just below timberline, particularly along the little streams where it grows in the grass and heather on the overhanging banks. It was flowering abundantly from the time of our arrival, the middle of July, until about the middle of August. (Identified by Miss Eastwood and Professor Greene.)

***Boschniakia strobilacea* Gray.**

Collected at Wagon Camp by Miss Wilkins. (Identified by Professor Greene.)

***Linnæa borealis* Linn. Twin Bell-flower.**

Fairly common along one of the streams half a mile north of Sisson Tavern, but not noticed elsewhere. This form was described by Torrey as variety *longiflora*.

Sambucus melanocarpa Gray. Blackberry Elder.

Common in moist parts of the Transition zone, particularly in the canyons. (Identified by Professor Greene.)

Symphoricarpos racemosus Mich. Snowberry.

Common about Sisson Tavern and in cool moist places along the base of Mount Eddy.

Symphoricarpos pilosus Greene. Mountain Snowberry.

Abundant in the upper part of the Transition zone, particularly at Wagon Camp and along Squaw Creek. (Identified by Professor Greene.)

Campanula wilkinsiana Greene.¹ Shasta Bluebell.

This new bluebell, recently described by Professor Greene from specimens collected by us on the upper part of Squaw Creek, is common in the lower heather meadows, and less so in the marshy place at Wagon Camp. It is singular that the only *Campanula* found on Shasta should be new, the usual Sierra and Cascade species being absent. The present species, which is named after Miss Lewanna Wilkins, averages 4 to 5 inches in height and has a rather small flower. Its zone position is Hudsonian and Canadian.

Achillea lanulosa Nutt.

Common in the Transition zone at and below Wagon Camp. (Identified by C. L. Pollard.)

Achillea borealis Bong. Dwarf Alpine Yarrow.

Occurs in places on the stony pumice slopes above timberline. Between the heads of Mud and Squaw creeks Vernon Bailey found it at an altitude of 9,600 feet. (Identified by C. L. Pollard.)

Anaphalis margaritacea (L.) B. & H.

Common in dry open places in the chaparral from Sisson to Wagon Camp. (Identified by Professor Greene.)

Antennaria geyeri Gray. Geyer Everlasting.

A large specimen of this handsome everlasting was collected by Vernon Bailey in the Transition zone just below Wagon Camp September 25. The species was not noted elsewhere. (Identified by Miss Eastwood and Professor Greene.)

Antennaria media Greene [= *A. alpina* Auct.]. Alpine Everlasting.

Common in open parts of the Hudsonian zone in the neighborhood of timberline on most parts of Shasta and on Shastina. On ordinary slopes it ranges from an altitude below 8,900 feet up to about 9,000. (Identified by Professor Greene.)

¹ Pittonia, IV, pp. 38-39, March 17, 1899.

***Arnica merriami* Greene.¹**

Common in the heather meadows and along the edges of streams in most parts of the Hudsonian zone. This new species has just been described by Professor Greene from specimens collected by us on the moist banks of the small west arm of Upper Squaw Creek, under the alpine hemlocks, where it is very common.

***Arnica longifolia* D. C. Eaton.**

Common in moist places in the Canadian zone, chiefly on the banks of streams. (Identified by Professor Greene.)

***Arnica viscosa* Gray.**

This singular species, which differs strikingly in appearance and habit from most members of its genus, grows in dense patches, usually 2 or 3 feet in diameter, among the bare lava rocks on steep slopes near timberline. On the south side of Shasta it was fairly common and flowering abundantly in August. (Identified by Miss Eastwood.)

***Artemisia tridentata* Nutt. True Sagebrush.**

Sagebrush is unknown in the region about Shasta except in Shasta Valley, which it invades and overspreads from the Klamath country on the north. It reaches the extreme south end of Shasta Valley and penetrates a short distance into the bordering forest of ponderosa pines, where it mixes with *Kunzia tridentata*. Pushing southeasterly over Shasta Valley it reaches the gap at Sheep Rock. Its zone position is Upper Sonoran and Transition.

***Artemisia ludoviciana* Nutt.**

A form of *Artemisia ludoviciana* is common in places just below Wagon Camp, along the upper edge of the Transition zone. When the species and subspecies now lumped under the above name are properly defined, several useful zone plants may be added to their appropriate lists.

***Machæranthera shastensis* Gray. Shasta Alpine Aster.**

[=*Aster shastensis* Auct.].

A dwarf alpine species abounding on the bare rocky pumice slopes in the neighborhood of timberline, and common also on the borders of the heather beds in the glacial meadows. This is the type form. A related but unnamed form, usually a foot and a half or more in height, is common and widely distributed on the lower slopes, chiefly in the upper part of the Transition and lower part of the Canadian zones.

***Oreastrum alpinum* (Gray) Greene.**

Common in the neighborhood of timberline, particularly in moist places. (Identified by Professor Greene.)

¹ Pittonia, IV, p. 36, March 17, 1899.

Chænactis nevadensis (Kellogg) Gray. Alpine Chænactis.

This curious composite, with whitish tubular flowers, much divided sticky leaves, and a smell like that of alcoholic specimens, occurs here and there in the pumice sand and among the broken lava shale above timberline. It was first seen in flower on the north side of Shastina July 24 (alt. 9,000 feet), and early in August was flowering plentifully on the south slope of Shasta above the head of Squaw Creek (alt. 9,300 feet). (Identified by Professor Greene.)

Chrysothamnus bloomeri (Gray) Greene.

One of the commonest and most widely distributed plants of the higher slopes, where it occupies pumice soils from the bottom of the Hudsonian zone up to several hundred feet above timberline. It was rarely found above an altitude of 9,000 feet.

This plant is very long lived, and although the part above ground is relatively small it springs from a large woody base resembling that of the true sagebrush. The root is enormous. The main taproot (sometimes double) usually sinks so deeply into the soil that I was unable to dig one up without breaking off the terminal point. In mature plants the main root measures about 200 millimeters in circumference where it enters the ground, and is 500 to 600 millimeters in length. It gives off numerous small and slender rootlets some of which exceed 600 millimeters in length. The height of the plant above ground rarely exceeds 150 millimeters.

Chrysothamnus bloomeri angustatus (Gray) Greene.

Common at Wagon Camp and in various parts of the Transition zone, usually scattered through the manzanita chaparral. Vernon Bailey collected it at Sheep Rock. (Identified by Professor Greene.)

Chrysothamnus occidentalis Greene. Rabbit Brush.

Fairly common in open spots on the lower slopes throughout the Transition zone, where it is mixed with *Kunzia tridentata*, *Arctostaphylos patula*, and *Ceanothus velutinus*. This large white-stemmed species occurs sparingly in dry soil at Sisson, and thence to Edgewood and Shasta Valley, in the upper edge of the Upper Sonoran zone, where it is common among the sagebrush. It was obtained at Sheep Rock by Vernon Bailey. (Identified by Professor Greene.)

Chrysothamnus viscidiflorus Nutt.

Common in the upper part of the Upper Sonoran zone in Shasta Valley. (Identified by Professor Greene.)

Erigeron armeriaefolium Turcz.

Rather common near timberline. Specimens were collected above Squaw Creek, near the head of Mud Creek Canyon, and on the north slope of Shastina. (Identified by Professor Greene.)

Erigeron compositus trifidus Hook.

Common on the slopes of broken shale and pumice above timberline, where it often grows in mats of *Silene suksdorfii* close under the edges of rocks. On the south side of Shasta it was not observed lower than 9,200 feet, but on the cold north slope of Shastina it was found as low as 8,900 feet. Its yellow flowers are rather conspicuous, and were noted from the latter part of July until late in August. (Identified by Professor Greene.)

Erigeron inornatus Gray.

This tall and much-branched *Erigeron* was found in Mud Creek Canyon and along Squaw Creek, a little below the fall, at an altitude of 6,800 feet. (Identified by Professor Greene.)

Eupatorium occidentale Hook.

Collected by Vernon Bailey and Miss Wilkins on Horse Camp Trail on the boundary between the Transition and Canadian zones. (Identified by Professor Greene.)

Heleniastrum rivulare Greene.

Common on damp ground at Wagon Camp, on the boundary between the Canadian and Transition zones. (Identified by Miss Eastwood.)

Hulsea nana Gray.

A common and characteristic plant of the barren alpine slopes above timberline, where its showy yellow heads are conspicuous among the bare rocks. Its leaves are sticky, crinkled, and relatively smooth. It was found on most of the high ridges above timberline all the way around the mountain, and was obtained on the north side of Shastina at an altitude of 9,000 feet. Its highest limit on the southwest side, as observed by Vernon Bailey, is 11,300 feet. (Identified by Miss Eastwood and Professor Greene.)

Hulsea larseni Gray.

Common on the pumice slopes above timberline, growing with *H. nana*, from which it may be easily distinguished by the leaves, which are covered with a dense whitish pubescence. (Identified by Professor Greene.)

Madia bolanderi Gray.

Very common in the marsh at Wagon Camp, where it was in blossom all summer. Common also along some of the streams in the upper part of the Transition zone, where the low temperature resulting from the water carries narrow tongues of Canadian zone species down to altitudes below their normal limits. (Identified by Miss Eastwood.)

Senecio trigonophyllus Greene.

Common along Panther Creek in the Shasta fir belt. (Identified by Miss Eastwood and Professor Greene.)

Senecio canus Hook.

Common on the rock-strewn pumice slopes above timberline. (Identified by Miss Eastwood and Professor Greene.)

Solidago elongata Nutt.

Abundant in open grassy places at Wagon Camp, where it was in flower in August and September. (Identified by Professor Greene.)

Agoseris monticola Greene.¹ Alpine Dandelion.

Abundant in the neighborhood of timberline on the stony slopes and basins, where its yellow dandelion-like flowers were conspicuous from the end of July until the middle of September. On warm southerly slopes it was observed as high as 9,750 feet. Its wavy leaves are sometimes entire, sometimes indented or cut. This species has just been described by Professor Greene from specimens collected by us at timberline on Shasta.

Crepis intermedia Gray.

Collected by Miss Wilkins in Mud Creek Canyon near the mouth of Clear Creek, where its zone position is either Hudsonian or Canadian. (Identified by F. V. Coville.)

Hieracium albiflorum Hook.

Common in places along the upper part of the Transition zone. Collected at Wagon Camp, on Squaw Creek, and on a warm slope in Mud Creek Canyon near the mouth of Clear Creek. (Identified by Miss Eastwood and Professor Greene.) A dwarf alpine form, apparently not yet named, occurs above timberline and is fairly common above the head of Squaw Creek, growing with *H. horridum*.

Hieracium cynoglossoides nudicaule Gray.

Very common in the Transition zone just below Wagon Camp. (Identified by Professor Greene.)

Hieracium horridum Fries.

Common in places on the higher slopes at and above timberline, forming small and densely hairy tufts among the rocks. The plant, particularly when young, is completely covered by a very dense growth of stiff silky white hairs which give it a woolly appearance.

Hieracium gracile Hook.

Common in the heather beds just below timberline, where its conspicuous yellow flowers were in blossom the early part of August. (Identified by Miss Eastwood and Professor Greene.)

Hieracium greenei Gray.

Fairly common just below Wagon Camp in the Transition zone. The type locality of this species is in the Scott Mountains a little west of Shasta. (Identified by Professor Greene.)

¹ Pittonia, IV, p. 37, March 17, 1899.

Ptiloria lactucina (Gray) Greene. (= *Stephanomeria lactucina* Auct.)

This curious composite, with milky juice and conspicuous pinkish flowers, suddenly appeared on burns near Wagon Camp the latter part of August. It was not observed elsewhere. (Identified by Miss Eastwood and Professor Greene.)



FIG. 46.—Monument on summit of Shasta. (Photographed by W. H. Osgood.)

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